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GOOD FRUIT FARMING

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in the
FARMING and AGRICULTURE
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Prepared under the special direction and scientific Editorship of

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GOOD FRUIT FARMING

18, 11, 295

By

C. R. THOMPSON

Consultant on Good Fruit Growing
now of Goldsmiths, Joy Lane, Whitstable,
Kent.

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EDITORIAL PREFACE

VERY briefly, Mr. C. R. Thompson tries in this interesting volume to put before us an ideal in the production of Good Fruit. If there is to be *Good Fruit Farming*, the grower must aim at an extremely high standard of efficiency in his business, and our author strives, in the present book, to show us what that standard is and how by patience, skill and knowledge it can be attained.

Mr. Thompson has a high reputation as one who knows, from long acquaintance with the practical side of his subject, how the grower should proceed ; and chapter by chapter he unfolds for us the deep secrets of his craft. I venture to state that this is a book of outstanding merit and I believe that its perusal will be of the greatest benefit to all who have either commercial or academic interests in the topics with which it deals.

Mr. C. R. Thompson's wide experience includes the early training he obtained at the Long Ashton Fruit Research Station, where he devoted considerable attention to the problems of the pruning of fruit trees. His particular contribution to Horticulture has been the development of that ingenious method of pruning known as the Renewal System. Before his time commercial growers had become dissatisfied with the old-established and finicky pruning systems which they had inherited from private garden practice. Mr. Thompson pointed out a way in which it would be possible to establish a system better suited to the needs of commercial practice. Incidentally his methods made it possible not only to achieve heavier cropping but also to ensure regular and predictable cropping of top-fruits instead of those wide fluctuations previously all too familiar to the older commercial fruit growers.

Among the horticultural developments of the last twenty years or so none has been more spectacular than this work of our author. It has been compared in importance with the John Innes Institution's work on Soil Composts.

S. GRAHAM BRADE-BIRKS.

PREFACE

This volume designedly begins at the beginning of things and is intended to instruct, at first, those with no previous experience of the subject. As the book progresses, its pages unfold sufficient of the complicated study of fruit-farming to bring the standard *of knowledge* up to that of a good grower.

I am fully aware that there are already several good books on the market about fruit-growing but I am also conscious of the fact that there is little that caters for the student as such. The serious student is in need of a text-book at a reasonable price and in the first instance, therefore, it is for him that this book is written. Thus it is meant not only for those whose course of horticultural study includes the subject of " Fruit " (dealt with in a general or elementary manner) but also—and more particularly—for all who intend to make a career for themselves in good fruit-farming.

A number of mental qualities are required by every good fruit-grower. He must, of course, possess up-to-date knowledge, that goes without saying; but also a keen farming sense is absolutely necessary and administrative and business abilities are essential to real success. The present volume sets out to provide the first of these requirements and because it is planned to impart an up-to-date knowledge of the subject, most of the space available is devoted to the straightforward story of the operations that are carried out on an efficient modern fruit farm and in explaining why they are done.

The successful business of fruit-farming entails not merely familiarity with the various plants, trees and varieties comprised in the wide range of crops grown; it has also to do with soil, nutrition, cultivation, pruning, use of rootstocks, pollination, propagation, control of pests and diseases, and the use of implements as well as with the operations of harvesting, storage and marketing. For the convenience of my readers I have divided the subject up into a number of these essential parts, devoting a chapter to each for the sake of clarity.

I hope that many of my fruit-farming friends will read this book and will see in it something to commend to younger folk, and that perhaps they may find some points in its more advanced parts to reward them personally for looking through many pages that are elementary and intended for beginners.

I wish to express my grateful thanks to Dr. S. Graham Brade-Birks and to Mr. Edward Vinson; to the former for the willing and painstaking help given to me at all stages in the preparation of this book and to the latter for reading my manuscript and for teaching me so much about that sound practical sense that goes to make up good fruit-farming.

C. R. THOMPSON.

Goldsmiths,
Joy Lane,
Whitstable, Kent.

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INTRODUCTION

Books about fruit growing, in common with those that deal with other farming pursuits enumerate the many and varied processes entailed. This book follows the orthodox pattern in that it is essentially a record of processes to which the business of Fruit Growing commits him that follows it. These processes are of two kinds, viz: (1) Those which recur frequently and (2) Those of infrequent occurrence.

1. PROCESSES WHICH RECUR FREQUENTLY.

These include (i) Pruning, (ii) Manuring, (iii) Cultivation, (iv) Spraying, (v) Pollination, (vi) Harvesting, Marketing and Storage.

(i) Pruning.

The practices of removing, either entirely or in part, branches, shoots and roots as well as removing pieces of bark and buds, is summed up in the term "Pruning." With the exception of Strawberries, all the fruits under consideration (see p. 41) benefit by some form of pruning and the benefits that may be gained are in most instances of sufficient commercial value to merit application every year. The pruning treatments advised for the various types of fruit are dealt with in Chapter VII.

For cane fruits the pruning treatment is the same every year but in the case of soft fruits that are grown as bushes, the treatment during the initial formative years is different from that given to fully established bushes. In the case of tree fruits pruning can make a valuable contribution towards the rapid development of well formed trees and the main emphasis of treatment during the first few years should be in this direction. After this stage, tree fruits such as cherries, plums, and damsons as well as certain apple varieties require little pruning treatment other than a degree of regulation of branches and shoots so as to prevent crowding and the consequent detrimental effects of excessive shade. Pruning may also be employed for trees of this kind to facilitate general management in cultivation, harvesting, spraying and so forth. With apples and pears the pruning treatment will vary greatly according to the behaviour of the trees. Of necessity the aim in all cases is to secure productive crops regularly and to do this the pruning is not likely to be the same for trees that are growing excessively and

are disinclined to crop, as for trees that are making poor growth and are yielding profuse crops of small fruit. At times, exceptional pruning measures in the nature of " ring pruning " or " root pruning " are advisable (see p. 166) but these are most likely to apply to closely planted trees such as Cordon and Dwarf Pyramids that are making excessive growth and for which drastic measures are required to reduce vigour and to increase productiveness.

Pruning is specifically concerned with the most advantageous utilization of vigour. While it is a primary function of soil treatments such as manuring and cultivation to secure so far as possible, the requisite amount of growth and while the primary function of spraying is to safeguard development, it is a function of pruning to determine where the growth is to take place and to what use it is to be put.

(ii) Manuring.

So far as fruit is concerned, the frequent application of manures and fertilizers is an essential of good husbandry. Application whether of manures or fertilizers is commonly referred to as manuring. Manuring must be done with considerable discrimination, because not only do soil conditions and the requirements of the different fruit crops differ, but the various manures and fertilizers supply different mineral constituents, in different forms and quantities. A mineral present in some manures and fertilizers may be absent in others and some may supply considerable quantities of organic matter whereas in others there may be no organic matter at all, or only a negligible amount, when judged from the standpoint of manurial values. There are three principal reasons for manuring; they are:—

(*a*) To correct mineral deficiencies.
(*b*) To meet the nutritional needs of the crop grown.
(*c*) To develop and maintain the soil in a fertile state.

It is evident that the best values from manuring are most likely to be gained when treatments are applied with due consideration for the needs of a crop and for the type and state of soil conditions.

Chapter VI is devoted to manuring. Some space is given in it to the question of mineral deficiencies and guidance is given concerning field recognition of those most usually occurring. The correction of an existing deficiency should be given first place in any manurial programme, since it is futile and often wasteful to indulge in generous manuring in other respects so long as a sufficient quantity of the deficient element is not supplied.

Readers will not be surprised that crops of such different characters as say, blackcurrants on the one hand, and dessert apples on the other, require different manurial treatment if the best results from each are to be obtained. Blackcurrants have a high nitrogen requirement, they crop on young (one year old) wood and vigorous growth is required from them each season. Dessert apples have a relatively high potash requirement, fruit colour will suffer if nitrogen is in excess, and moderate vigour is required from them each season if good cropping is to be maintained. It is fitting therefore that the nutritional needs of each fruit crop should be discussed in some detail in the chapter devoted to manuring.

Good husbandmen not only take into view the immediate needs of a particular crop but they are concerned with the building up of a fertile soil medium, so as to secure favourable basic conditions for as wide a range of crops as the soil type allows, especially is this so when short term soft fruits are grown. In order to attain this éfficiency, factors like the nature of a soil (including the ease with which it can be worked and its moisture retaining properties) and the composition of a soil (including the organic matter and the mineral content) must needs be taken into account when considering manurial requirements.

Due consideration is given to the aspects of manuring in Chapter VI and the question of soils in relation to fruit is dealt with in Chapter I.

(iii) Cultivation.

Chapter V is devoted to the various tillage needs of the different fruit crops. The range is from totally clean cultivation, that is to say, a state which is to all intents and purposes free of weeds, e.g. for strawberries, and for soft fruits generally, to no cultivation where grass orcharding is practised for cherries and to a considerable extent for apples. In between these two extremes there is the alternating clean-dirty system of management where tree fruits, such as apples, pears and plums are provided with clean cultivation during the early Spring, as a means of assisting the conservation of moisture for the benefit of the crops during the active growing months, after which weeds are allowed to grow and are subsequently disced or ploughed in. Perhaps more than most operations, cultivations permit the establishment of a routine, and they are governed principally by suitable conditions for getting on to the land. Nevertheless changes in cultural management are sometimes advisable, as may be instanced in the case where dessert apples

grown under arable conditions are found to be making very vigorous growth and yielding poor crops of large fruits. In such cases, a change over from arable to grass management, at least for a number of years, would in all probability be justified and beneficial.

(iv) Spraying.

There are occasions when special measures not fitting into normal spray routine have to be taken to deal with a particular pest or disease. Most fruits have their own special range of pests and diseases which recur with almost uncanny regularity and which would be very damaging unless a regular spray schedule were followed each season. For most pests and diseases there is some latitude of choice in the form of spray by which they may be resolved, and although a routine may be the rule, it lends itself to variation and modification from time to time.

Of necessity efficient spraying for pest and disease control is dependant upon correct timing, the employment of suitable materials, and thoroughness of application. The matter of pests and diseases is dealt with in Chapter IX and of spray equipment in Chapter VII, whereas Appendix 6 is devoted to spray materials.

(v) Pollination.

The production of satisfactory crops is dependent upon the dissemination of suitable pollen. Whilst the grower may not be directly responsible for the process, but rely upon pollinating insects, it behoves him to see that his fruit varieties are distributed in such a manner as to ensure adequate supplies of suitable pollen in suitable proximity to satisfy the needs of pollination. In addition to this, many growers have colonies of bees in, or near, their orchards at blossoming time. Practical steps that the grower should take from the standpoint of providing effective pollination with the least inconvenience in general orchard management are described in Chapter IV.

(vi) Harvesting, Marketing and Storage.

Of necessity, growers must pay some regard to the manner in which their fruit is presented on the markets. The first essential is that fruit which merits presentation on the market, should suffer as little deterioration as possible in harvesting and transit. This implies that a form of package and manner of packing must be adopted in accordance with the requirements of the crop and the economic justification of the individual case. In general the softer and smaller the fruit to be presented on the open market, the smaller the package employed and the harder and larger the fruit, the larger the package employed.

With large fruit, firmness of packing is important to guard against vibration severe enough to cause bruising. This end can only be attained by systematizing the packing and by wrapping the individual fruits that have been size graded. Other features, including quality grades and standardized methods of presentation, emerge and enforce their legitimate claim upon all who are concerned with the secure establishment of an economic well-being for the home fruit industry.

It is a legitimate and fitting function of growers as a whole to aspire to a position to be able to satisfy, but not to saturate the market with produce that should do both the industry credit and give the purchaser satisfaction. That this cannot be achieved by growers as individuals is apparent and many growers are now firmly of the opinion that the matter can only be satisfactorily settled by the establishment of a marketing organisation. The political and economic aspects of marketing do not come within the scope of this book.

As things are at present certain fruits, especially the soft fruits, have to be marketed soon after they are harvested, whereas certain other fruits will keep in good condition for a considerable period. With produce that falls into this latter category the marketing can take place over a few weeks or months. As the production of home-grown fruit has increased and farm units devoted to fruit have grown in size, the commercial advantage of spreading the marketing over a period is clearly apparent.

In addition to the natural storage qualities possessed by some varieties of apples and pears, the storage life of many may be greatly prolonged without detriment to appearance or to quality, by the agency of low temperature and controlled atmosphere. Thus many growers now make use of what are known as gas stores and cold stores for keeping a considerable proportion of their storable crops. Not only does the possession of storage facilities help to provide a degree of continuity in marketing but it also helps to regularize, more to the factory pattern farm labour required for marketing operations.

Harvesting, marketing and storage are post-production processes and do not come within the scope of a book designed to teach how to grow good fruit. It is hoped that because they are only briefly dealt with in the short appendix devoted to them, their importance will not be overlooked by intending fruit growers (see Appendix 3, p. 273).

2. PROCESSES OF INFREQUENT OCCURRENCE.

These include (i) Propagation, (ii) Planning and Planting, (iii) Protection and Support, and (iv) Renovation.

(i) Propagation.

The subject of propagation is dealt with in Appendix 2. Although it is undoubtedly convenient and useful for a grower to know how to raise the various fruits, it is seldom essential to the success of his fruit growing enterprise. Some growers take a pride in raising their own nursery material, but most prefer to leave this side of the business to the specialist nurseryman. There are few growers whose requirements suffice to merit the establishment of a nursery. The business of propagation demands specialist attention because of the need for the production of disease free material especially in the case of certain soft fruits and for the maintenance of material that is true to name. Nevertheless, it is of great advantage if there is on fruit farms someone who knows how to do some grafting. Not only is a grafting process employed for raising young trees, grafting of various forms is also used for changing one variety over to another. There are reasons why such an eventuality may arise ; the two chief are : (*a*) to secure a more profitable sort, and (*b*) to provide for better pollination. Most fruit plantings remain in the same position for several years and the need for raising others of their kind seldom arises. Strawberries are the exception to this rule since they cannot be depended upon to merit retention after they are 3–4 years old. In view of this and of the fact that strawberries do not yield a crop of any consequence until the second year, it is necessary for the grower who intends to maintain a given fruiting acreage to make provision for a regular supply of young plants (i.e. runners).

(ii) Planning and Planting.

Fruit growing is not simply a question of digging some holes, planting some trees and waiting for the result. In the first place, if there is to be hope of commercial success, the venture should be knowledgeably planned. Fruit crops should be planted on soils and sites most suited to their development. This aspect is dealt with in Chapter I. Following this, there are such questions to be decided as kinds, varieties and planting distances (p. 52). The actual planting is simple enough but the marking out operation, in readiness for planting, is more complicated. Before planting can take place accurate marking out of a site is necessary so that exact positions to be occupied by the individual trees or bushes is defined. The various con-

siderations connected with planning and planting are dealt with in Chapter II.

(iii) Protection and Support.

Different forms of protection and support are necessary for most fruits in order to guard against injury by animals and by wind, and in some cases to make cultivation possible. The various requirements in this respect are described in Chapter II on Planning and Planting. In the case of tree fruits, the provision of supports to prevent their being blown over by the wind is generally necessary. Supports are needed for the naturally procumbent fruits such as loganberries and blackberries, in order to make cultivations practicable, and this usually applies also to crops such as raspberries and tree fruits when grown as Cordons or Dwarf Pyramids. Furthermore, on exposed sites, it is advisable to protect by planting windbreaks in well chosen positions. Whereas most forms of protection and support last for a number of years, the business of tying in canes such as loganberry, blackberry and raspberry recurs every year.

(iv) Renovation.

It sometimes falls to the lot of a grower to deal with established fruit that is old, or where the trees are too crowded, or where neglect is apparent. It may be that the profitable life of the plant has come to an end and the task of clearing the land in readiness for another crop is necessary, or it may be that only partial clearance is needed to provide more space from tree to tree. There are numerous causes that can, either singly, or in combination, bring about a state of neglect or an unprofitable condition, the most important of these being pests and diseases, unfavourable conditions both cultural and nutritional, neglected tillage, unsuitable varieties and inadequate pollination. These matters are dealt with under the general heading Orchard Renovation (Appendix 1).

3. MATERIALS AND EQUIPMENT.

The execution of the various processes, whether of frequent or of infrequent occurrence, of necessity involve the employment of materials and equipment. Since the kinds of materials and equipment available inevitably govern the value of the processes that are employed, much prominence is given to these matters in the ensuing pages. The most important of them are : (i) The soil (Chapter I), (ii) Manures and Fertilizers (Chapter VI), (iii) Spraying equipment (Chapter VIII), (iv)

Spraying materials (Chapter IX), (v) Rootstocks (Chapter III), and (vi) Fruit varieties (Chapter II).

4. THE FUNDAMENTAL APPROACH.

The newcomer to fruit growing may be like a housewife with a new recipe who expects to find "rule of thumb" directions. The business of fruit growing does not lend itself to the straightforward recipe approach that admits of no deviation. Whilst in some respects all growers, if they are to succeed, must adhere to similar methods and treatments, in others the rights and wrongs are not so clearly defined and practices that may be necessary and successful in some circumstances may be inadvisable and disastrous in others. The fruit grower has to contend with various factors over which he has little or no control, this is especially so in respect of soil and climatic factors. These uncontrollable and partially controllable factors are likely to affect both the general approach and the practices of a grower in a variety of ways. The choice of a crop for a particular site is governed by the response that can legitimately be expected and this too, will effect the choice of varieties, rootstocks and planting distances. The treatments that are applied after planting are governed by the response that is actually made ; and such treatments as cultivation, manuring and pruning must of necessity be varied to suit individual field requirements. Thus it is necessary in the ensuing pages to deal with a number of different fruits and to indicate treatments most suited to each. Although treatments and methods differ it is only because the primary aim of every fruit grower should be identical, viz. the regular production of the heaviest crops of acceptable market quality.

5. PRESENT TRENDS.

From time to time advances are made which either enhance the prospect of productivity or the value of the produce, and, of course, progressive growers are always ready to take advantage of such developments. In recent years production has increased very considerably as a result of advances in spraying technique, nutrition and pruning, this is true of each separately but especially to a programme in which they are employed in combination. In addition to the progress just mentioned, crop values have been greatly enhanced by the advent of modern storage facilities.

It is probable that advances will soon occur in the direction of increased mechanization, especially in respect of spraying

for low bush trees. Under most conditions, the advent of total mechanization for spraying operations should now present few difficulties in the cases of bush soft fruits and tree fruits, provided modifications in orchard layout are adopted (p. 53). Furthermore, the range of spray materials is growing, and with it, the enhanced possibility of pest and disease control together with reduced risks of spray injury. Gradually the full significance of the Renewal system of pruning is being grasped. Not only does the system enhance the prospect of securing crops whilst trees are young, it is quickly becoming the instrument by which trees are maintained at the size at which they are best fitted to yield their maximum crops while supplying a sufficiency of new surface each year to enable them to repeat the performance regularly (Chapter VII). It is not unlikely that much more attention will be given in the future to the pruning of plums, especially those of high grade dessert quality, and to the pruning of cherries for the purpose of facilitating harvesting and spraying operations by a limitation of height and a corresponding increase in spread.

In order to maintain fruit production at its peak it is more than likely that " gapping " up policies (i.e. the planting of young trees where casualties occur) will be increasingly abandoned in favour of grubbing and replanting a definite proportion of the total acreage each year, or once every few years (p. 243). The advantages of doing this from the standpoint of fulfilling modern requirements in such things as lay-out, varieties, spraying and pollination, are as self-evident as are those accruing from the increased rapidity with which young trees are established.

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CHAPTER I

SITE AND SOIL

The story begins with the soil and its situation, the considerations that render both site and soil suitable for the purpose of fruit growing and the choice of fruits for planting in relation to soil, site, labour and harvesting.

SITE AND SOIL.

Provided the necessary capital is assured good fruit farming begins with the choice of a suitable site with suitable soil. The importance of this dual requirement, site and soil, can hardly be exaggerated for it is the primary limiting factor upon which success or failure attends the efforts of the grower.

SITE.

The most important features that commend or condemn a site are :—

(i) Situation in relation to neighbouring and surrounding land.
(ii) Gradient rendering cultural operations easy or difficult.
(iii) Availability of suitable water supply.
(iv) Acessibility afforded by road and rail services.

(i) Most of the commercially grown fruit crops of this country blossom at a time when radiation frosts are of common occurrence. When such frosts are severe they have disastrous effects upon the crop production of any sites that readily lend themselves to an accumulation of cold air. This is especially so in the case of inland sites. A well-known expression that has common currency with fruit growers is the term " frost pocket." A typical example of a " frost pocket " is a site at the bottom of a valley which is a reservoir for the collection of cold air. Sites of this description should be studiously avoided whatever their promise in other respects.

It is not intended to imply that it is essential for all sites to enjoy immunity to frost damage, although the advantages

afforded by sites of this kind should not be lightly disregarded by intending fruit growers. It is generally admitted that some sites by virtue of possessing very favourable soil conditions will yield heavy average crops in spite of frequent losses due to frost. Unfortunately such sites crop most heavily during years that cropping is heavy generally, and the average price returns on a competitive market are not so good as from sites upon which greater reliance can be placed to crop with regularity.

The site to be favoured is one free from severe exposure and yet one on which cold air cannot stagnate but where its currents are free to move downhill to other situations. This implies some elevation, especially for inland sites, say 100–400 ft. above sea level, but with the proviso that obvious " pockets " are to be avoided even at high elevations.

The general appearance of the hedges and forest trees on a prospective elevated site are useful guides as to whether wind exposure is likely to be severe. The symmetrical development of hedges and trees is the best guarantee of suitable sites in this respect. When the windward face of hedges or trees has been turned away from the prevailing wind the site should be held suspect. At least it can be said that tree fruits should not be planted on such sites without providing adequate protection for the young growing tree. Windbreaks or shelter belts should be established in exposed positions preferably before the establishment of orchard or plantation fruit, although more often than not both are established simultaneously. Sites subject to severe exposure should not be planted to fruit.

(ii) In general, sites with steep gradients should be avoided because difficulties in tillage, spraying and harvesting would be encountered ; a further and serious disadvantage of such sites is that under arable conditions soil is eroded from the higher to the lower levels. Sites with steep gradients should not be applied to arable conditions for more than three or four years and even then it is advisable to leave grass strips at frequent intervals.

The ideal site is one that to all intents and purposes is flat but which has a gentle slope ensuring the flow of cold air to lower levels. Not only is it then possible to carry out all cultural operations with relative ease but also soil erosion is not likely to be serious, and the provision of effective wind breaks is a relatively simple matter.

(iii) A site should not be chosen for fruit, however attractive in other respects, if there is little likelihood of providing an effective water supply.

Unfortunately success in present day fruit growing cannot be guaranteed unless the necessary steps are taken to prevent or control specific pests and diseases. The only certain way of doing this, as things are at present, is by spraying ; and spraying involves the use of considerable quantities of water. Once apple trees are established they require several sprayings a year and each of these will require anything from 150–800 gallons of water per acre. Calculating a minimum of five sprays every year with an average consumption of 250 gallons per acre, something like 1,200 gallons of water per acre will be required annually for such fruit. You cannot plant fruit on the assumption that, by engaging in old and new nutritional devices, a pestless and diseaseless era will dawn.

(iv) The advisability of having good roads leading to a farmstead is self-evident, so too is the advantage of a railway station within easy reach.

SOIL.

Fruit may be grown with success under a wide range of soil types derived from different geological materials. Whether or not a soil is suitable for one or other of the commercially grown fruit crops depends primarily upon certain physical factors. The most important of these are (i) Depth, (ii) Drainage, (iii) Texture. Difficulties are often experienced in the growing of fruit crops because there are various faults in the mineral status of a soil. Fortunately little trouble is experienced in this country from the presence in the soil of excessive amounts of any mineral substance. Troubles due to deficiencies of particular mineral constituents, especially Potash, are both widespread and common. While unsuitable soil conditions due to mineral deficiencies can be put right by appropriate treatments (see Chapter VI), adverse physical conditions can seldom be corrected to any marked extent.

It is now possible, as a result of a number of fruit soil surveys to assess fairly accurately the minimum soil requirements of any fruit crop. Different crops have different minimum requirements in this respect and so it happens that soil that is unsuitable for one fruit crop is not necessarily unsuitable for all.

(i) Depth.

By virtue of the fact that there are very great differences in the depths of weathered soil (i.e. soil that has come under the ameliorating influences of the weather), some are more suited for the growing of large tree fruits than others. Very shallow soils, that is those of less than ten inches in depth cannot be

regarded as satisfactory for any fruit crop, because not only do they afford little room for root development, but they are also invariably subject to drought during the Summer months.

Shallow soils yielding 10–18 inches depth with good conditions of drainage and texture are suited to small plants such as strawberries and small trees such as Cordons and Dwarf Pyramids (see p. 46). More than 18 inches of weathered soil is desirable for the general run of tree fruits such as apples, pears, plums, damsons and cherries and for soft fruits such as blackcurrants, gooseberries, redcurrants, raspberries, loganberries and blackberries, although less depth is needed with heavy textured soils than with light ones. Cherries function at their best when planted where there is no impediment to the development of large trees, so that for them not less than 30–36 inches of weathered soil are acceptable.

(ii) Drainage.

The state of the natural drainage of a soil is at least of equal importance with soil depth. A deficiency or excess of water in a soil is a limiting factor governing the well-being of any fruit crop.

Fruit crops generally can be said to favour good drainage and this implies that soils subject to extremes of wetness and dryness should be avoided. Fortunately some fruits are tolerant of poorer drainage than others and, furthermore, a higher water table is permissible for fruits that do not require deep soils. Cherries, dessert apples, raspberries, redcurrants and gooseberries require well-drained soils whereas plums, damsons, blackcurrants, loganberries and several sorts of culinary apples will thrive under conditions of only moderately good drainage. Blackberries and pears succeed under far less satisfactory drainage conditions than those needed for most fruit crops, but there must be ample soil moisture during the summer months. Strawberries require good drainage for the top 6–9 inches, but will thrive where there is a high water table.

The question naturally arises when a soil is too wet for the successful cultivation of a particular fruit crop on an otherwise suitable site as to whether sufficient improvements in drainage can be brought about by artificial means.

There are strict limitations to the good that can be done by artificial drainage. The diversion of spring water through land pipes to conduct surplus water away from localized wet spots is oftimes a both practicable and valuable expedient. Substantial improvements may also be brought about by pipe draining poorly drained deep soils, especially when they are

intended for the small growing soft fruits. Deep pipe draining on shallow soils is of doubtful value especially when the pipes are deeply embedded in underlying material, subsoil or rock, that is to all intents and purposes impervious to water. Pipe draining for tree fruits is only partially satisfactory on account of the frequent dislodgement of pipes occasioned by the tree roots. Land furrows may often be employed with good effect to conduct surface water away with the least possible delay.

In general, a soil should possess the natural and inherent drainage requirements necessary for the growing of a particular fruit crop and only in borderline instances is it wise to anticipate that any artificial systems will effect sufficient improvement to raise the standard of the land to the minimum required.

(iii) Texture.

Soil texture, although important, is of less importance than soil depth and natural drainage. Given suitable depth and drainage, most fruits will succeed on soils ranging from easily worked sands to heavy clays (technically, loamy sands to clay loams). Nevertheless there are certain fruits concerning which soil texture is an important consideration, and some soils the texture of which is unsuited to the successful development of particular fruits. Cherries do not thrive on heavy textured soils. Strawberries and raspberries should generally be favoured with light, easily worked soils. A small-growing plant like the strawberry demands conditions that readily lend themselves to the control of weeds from early spring onwards until autumn. A soil, even if it is sandy and easily worked, is generally unsuited for fruit crops when clay occurs at a depth of less than three feet. Strawberries are a possible exception, but even they should be avoided if there is only a thin layer of sandy material, because drainage irregularities may occur under such conditions.

KINDS OF FRUIT AND SOIL REQUIREMENTS.

The kinds of fruit that are normally grown by the commercial fruit growers of this country have already been mentioned. It is fitting therefore at this stage to list these various fruits to indicate a minimum standard of soil condition required by each.

MINIMUM STANDARD OF SOIL CONDITIONS REQUIRED BY DIFFERENT KINDS OF FRUITS.

Kind of Fruit and Remarks.	*Kind of Soil.*		
	Depth in inches.	*Drainage.*	*Texture.*
Tree Fruits.			
Cherries	30	Very Good.	Light-Medium.
Apples (Dessert). For wide planting	18	Good.	Light-Heavy.
Apples (Dessert). For close planting (e.g. Cordons) ..	12	Good.	Light-Medium.
Apples (Cooking). For large-growing, sturdy-wooded sorts	21	Moderate.	Light-Heavy.
Apples (Cooking). For small to medium-growing, slender-wooded sorts ..	18	Good.	Light-Heavy.
Plums	18	Moderate.	Medium-Heavy.
Damsons	18	Moderate.	Medium-Heavy.
Pears	18	Moderate-Poor.	Light-Heavy.
Soft Fruits.			
Raspberries	15	Good.	Light-Medium.
Redcurrants	15	Good.	Light-Heavy.
Gooseberries	15	Good.	Light-Heavy.
Blackcurrants	15	Moderate.	Light-Heavy.
Loganberries	15	Moderate.	Light-Heavy.
Blackberries	15	Moderate-Poor.	Light-Heavy.
Strawberries	9	Good.	Light-Medium.

CHOICE OF FRUITS FOR PLANTING.

It is seldom practicable for a grower to go in for all the kinds of fruit enumerated above. In addition to the likelihood that a grower may have a personal preference for particular kinds of fruit there are four main reasons that serve to limit choice to a few of the kinds. The reasons for these limitations are : (i) Suitability of soil, (ii) Situation, (iii) Labour considerations, (iv) General considerations.

(i) Suitability of Soil.

To apply land to a crop for which it is more or less ideally suited should be regarded as a fundamental principle admitting few exceptions. The advantage of doing this is of equal importance where an extensive site of uniform soil conditions is concerned, as it is when the site is split up into small units of differing soil types. The soil on some sites is uniformly good, and all kinds of fruit under consideration could be grown there with success. However, many sites very well suited to the general run of fruits, may be unsuited to certain kinds which happen to require special conditions of soil depth, drainage and workability. For instance, strawberries and raspberries may be ruled out of question when the soil is very heavy. The cherry comes into a category of its own, and there are many otherwise good fruit sites where it would be unwise to attempt to grow cherries. The dessert apple too, must often give place to other crops, nevertheless there are many good fruit farms where culinary apples and plums are the two main crops.

(ii) Situation.

Some sites, by virtue of their elevation, aspect, locality and other factors that define situation, are better suited to the earlier ripening fruit varieties than to others. Without question it is highly desirable that a grower should take advantage of a site's natural potentialities in this direction. Not only is it generally unwise to grow the earlier ripening varieties of the various sorts of fruit on late sites; it may also be unwise to grow crops such as gooseberries, raspberries and blackberries, and possibly strawberries, which only command the best prices on the early market.

With cherries and the soft fruits which are mostly harvested during the months of June and July, it is important to have situations affording relatively dry harvesting conditions. The skin of ripe or nearly ripe cherries is apt to split after rain and a crop can easily be ruined in this way. Before embarking upon cherry growing on any site, one should first be assured of good average harvesting conditions. As for soft fruits, in particular those kinds which cannot be harvested by one but by several pickings, e.g. strawberries and raspberries, there may be great difficulty from the weather.

(iii) Labour Considerations.

No crop should be planted unless there is good reason to believe that the necessary labour will be forthcoming, both for production and harvest. The successful harvesting of soft

fruits entails the provision of a plentiful supply of temporary labour, and because most soft fruits are in season more or less at the same time (i.e. during July and August) the number of different kinds that can be grown and the acreage that can be devoted to each, is governed by the labour force available. Though this is true of all fruits, it is especially so of kinds that are quickly perishable because they allow only a small margin of time for harvesting and marketing in good condition.

When embarking upon soft fruit growing without previous experience, it is wise to limit the choice of crops to a few sorts, say gooseberries, strawberries, blackcurrants and raspberries and to devote only a small acreage to each, say 1–5 acres. By so doing it is possible to begin harvesting early in the season and to retain the same gang of labour for a long period. Early green gooseberries are the first on the list for harvesting and strawberries follow and then in turn come blackcurrants and raspberries. Blackcurrants and raspberries are harvested over the same period but fortunately most sorts of blackcurrants will hang on the bushes for several days when ripe without deteriorating and can be harvested between successive raspberry pickings. Care must be exercised in the selection of varieties of the different kinds in order to establish a satisfactory cropping sequence (see recommended varieties pp. 54–60).

(iv) General Considerations.

On personal grounds some growers have a preference for growing certain fruits as distinct from others. Fortunately, success in fruit growing is not conditional upon growing several kinds. In fact, it is far more probable that a prospective grower will succeed better by confining his attentions to only a few kinds. Some of the most successful fruit growers in the country are concerned in the cultivation of two or three kinds. In general, the larger the enterprise the fewer the kinds that are wanted and the greater the degree of specialization.

Some growers embark upon soft fruit growing with the intention of making this a permanent occupation, whereas others do so only as a temporary measure until tree fruits begin cropping. The latter category should limit choice to the short term soft fruit crops such as strawberries, raspberries and blackcurrants. There is a third type of grower who is always tempted to indulge in soft fruit growing at times when the market is good, little thinking that many others are doing the same thing and that the market supply will have greatly increased by the time his are in full cropping. This policy in reverse is likely to be much more effective, but as it stands must

be deprecated unless there is good reason to believe that saturation point will not readily be reached.

THE MAIN PERIODS OVER WHICH THE DIFFERENT KINDS OF FRUIT ARE HARVESTED.

Gooseberries	May–JUNE–July.
Strawberries	JUNE–July.
Cherries	JUNE–Aug.
Blackcurrants	JULY.
Redcurrants	JULY.
Raspberries	JULY.
Loganberries	July–AUG.
Apples	July–Aug.–SEPT.–Oct.
Pears	July–AUG.–SEPT.–Oct.
Plums and Damsons ..	July–AUG.
Blackberries	AUG.–Sept.

(*The names of months printed in capitals indicate the peak of harvesting*).

CHAPTER II

PLANNING AND PLANTING

The planting of fruit should be done on well-conceived plans. Suggestions are made for the acreage allocation of a hundred acre mixed fruit farm. Methods of growing and types of trees must be chosen, planting material secured, planting distances and planting arrangement determined, and the soil prepared for planting. The protection of trees and crops must be secured. The marking out of the site, the actual planting operation and the provision of supports, where necessary, are parts of the initial planting requirements. A careful selection of varieties is essential. Several other factors affect planting plans; such are pollination and interplanting, and these are discussed.

SECTION I

ACREAGE, MATERIAL, VARIETIES AND ARRANGEMENT. Although not essential, it is normally considered good practice when developing a new fruit holding to devote a proportion of the acreage to soft fruits and arable crops or temporary grass leys and the remainder to tree fruits. The reason for maintaining a small arable and grass acreage is because frequent changes of soil are required for short term crops such as strawberries and raspberries on account of diseases to which they are subject. The soft fruits will require most labour from June to August, the harvesting period, whereas the tree fruits will need most from August to October (see p. 41). Although it is wise to avoid undue fluctuations in labour commitments no plan can avoid there being certain rush seasons. It must be appreciated that any suggested plan for planting, no matter how sound from the standpoint of balance and labour, is arbitrary, because considerations of soil,

situation, size of field units and personal factors make it necessary to consider each farm and each field separately according to its merits.

Successful planning for the future is, in the writer's opinion, dependant upon four primary factors, viz. (i) Suitability of soil and site, (ii) Choice of suitable market varieties, (iii) Large enough units to afford relative ease of management, (iv) Storage and marketing facilities.

(i) For considerations concerning soil and site see Chapter I (pp. 33–40).

(ii) For considerations concerning choice of suitable market varieties see Chapter II (pp. 56–60).

(iii) The large unit has a very great advantage over the small unit especially for tree fruits. This is largely due to the increasing tendencies towards mechanization and standardisation of produce. In general, small units do not lend themselves to an efficient employment of mechanical power, and the advantage of reduced production costs cannot be reaped to the same extent as with large units. There is no real justification for the belief that by increased specialization on the small unit, increased crops will result to compensate for the increased costs of management, though it may be true during the early years either because of the large number of trees planted per acre or on account of various systems of interplanting, but later on the advantage goes to the planting lay-out which provides that adequate space which contributes towards ease of management.

(iv) In order to secure the most favourable market for late apples and pears, a grower should be in a position to hold a fair proportion of his crop in storage so that it can be dispatched at the most propitious time. It might be argued that as increased storage space on a holding became available to fruit, the price margin was not likely to vary so much as when the storage accommodation was small. This may be true but the business mind will not be slow to grasp the many advantages to be gained by spreading the marketing of his crop over as long a period as possible.

It is doubtful whether modern storage and packing facilities are to be justified on a production of less than 30,000 bushels (600 tons approximately) of apples and pears. This figure should represent the production of 60–120 acres, although greater weights than this can be expected from some varieties. There should be storage space for at least one third of the 30,000 bushels and this would suggest that a fruit holdin-

should have something in the region of 60 acres devoted to acceptable storage varieties of apples and pears. Supposing less than this is contemplated and it is clearly evident that the provision of storage and marketing arrangements for personal use are out of the question, a grower would do well to seek facilities in co-operation with other growers.

PLAN OF DEVELOPMENT FOR A 100 ACRE FRUIT FARM.

Given suitable conditions of soil and site and the assurance of an adequate supply of labour, the following may be regarded as a suitable lay-out for a 100 acre farm.

SOFT FRUITS.

Plus arable 0–25 acres ; could be allocated on the following lines :—

Gooseberries. 0–2 acres in early situation or for early labour.

Strawberries. 0–6 acres on easily worked soils and for preference in an early situation.

Raspberries. 0–6 acres on easily worked soils.

Blackcurrants. 0–12 acres preferably on medium to heavy soils.

Redcurrants. 0–2 acres on light to medium soils when raspberries are grown but no blackcurrants.

Loganberries. 0–4 acres on medium soils if no raspberries are grown.

Blackberries. 0–2 acres on medium to heavy soils in an early situation.

Arable or Grass. 0–12 acres.

TREE FRUITS.

75–100 acres could be allocated on the following lines :—

Cherries. 0–10 acres. These should only be planted under suitable soil and climatic conditions. Tree fruits such as plums and soft fruits such as strawberries may be planted as an intercrop.

Plums. 2–10 acres.

Apples and Pears. (Early–Midseason) 10–20 acres.

Apples and Pears. (Late) 40–60 acres. Suitable storage varieties.

It is not intended to suggest that some of all the different kinds of fruit should be chosen, in fact it is preferable especially in the case of soft fruits to limit the choice to only two or three kinds. Efficient planning is not finished with the allocation of specific acreages to particular crops. The provision of planting material, decisions regarding planting distances and selection of varieties, the preparation of the land and the protection against wind and animals are all essential preliminaries to the actual planting operation.

CHOOSING THE GROWING METHOD AND TREE TYPE.

With soft fruits there is little difference from farm to farm either of growing methods or of planting distances, except for loganberries and blackberries, where different methods of providing support for fruiting canes do account for some difference in cultural technique. Similarly cherries, plums and damsons afford little opportunity for any but the orthodox method of culture. As for apples and pears, considerable differences occur in respect of form of tree, planting distances and cultural technique. It is proposed at this juncture to tabulate the various growing methods and tree types of commercial significance.

SOFT FRUITS.

Strawberries.	Small plants called "runners" (see pp. 51), are planted in rows (see p. 264) both rows and plants occurring at regular distances apart.
Blackcurrants. Redcurrants. Gooseberries.	As bushes in rows, both rows and bushes occurring at regular distances apart. (see pp. 51, 263).
Redcurrants. Gooseberries.	As bushes usually with short stems, referred to as "leg" (see p. 263).
Blackcurrants.	As bushes with no stem, referred to as "stool" (see pp. 49, 263).
Raspberries.	As rooted canes to form stools (see p. 263).
Loganberries. Blackberries.	As rooted tips to form stools (see pp. 51, 265) planted at regular intervals both in the rows and between the rows.

TREE FRUITS.

These all have a main stem, when the stem is short, i.e. not more than 3 feet tall before a branching head is formed, they are referred to as " Bush " trees. When the main stem of a tree is taller than 3 feet, but not more than 5 feet, it is called " Half-Standard " ; and the term " Standard " is used for trees with stems of between 5–7 feet tall. In addition to the Bush, Half-Standard and Standard trees there are Oblique Cordons and Dwarf Pyramids. The Oblique Cordon has a single sloping stem and this stem is furnished with lateral development. The Dwarf Pyramid has a central, erect stem which may be as much as 6 feet tall and this stem is furnished with numerous short branches over its entire length, save at the very base. The longest branches which are nearest the base are seldom more than 3 feet long. One year old trees are generally called " maidens." A maiden tree may have a single, clean stem, or it may have a number of side shoots in which case it is referred to as a " feathered maiden." For trees that have been pruned to form a branching head, the term " One Year Headed Trees " or " Two Year Headed Trees " are employed depending on the age of the head. For two and three year old trees that have not been pruned, the terms two and three year old " Whip " is used.

Apples. These are grown as Bush, Half-Standard, Standard, Cordon and Dwarf Pyramid Trees. The Bush is the form of tree that is commended for the most general commercial application especially for dessert apples and sorts that make relatively small trees. For sorts that normally form large trees (e.g. Bramley Seedling on Rootstocks other than Type IX see p. 84) cultural difficulties arise when grown as Bush, and because of this the Half-Standard tree is favoured.

Standard trees are best planted when it is intended subsequently to apply to grass to be grazed by livestock.

Cordon and Dwarf Pyramid trees have only limited commercial application, since they seldom offer greater prospect of increased crops per acre over the bush type and they are established at a considerably greater capital outlay. Care should be taken not to devote deep, fertile soils to these forms in view of difficulties that will be experienced as a result of vigorous growth, a condition that should be avoided with close planted trees. Soils that are not conducive to vigorous growth, but are suited to the production of small trees (e.g. well drained but relatively shallow soils) should be favoured for the Cordon and Dwarf Pyramid types. Furthermore, success is conditioned

by the employment of rootstocks that are sufficiently dwarfing in their effect (see p. 82).

Pears. Similar forms of tree can be employed for pears as for apples and in common with this crop the bush type lends itself to the widest commercial application. In point of fact they have only limited application as Standard or Half-Standard trees, since pears are normally best under arable conditions and on Quince rootstocks (see p. 87) and this form of rootstock is not ideally suited for the establishment of big trees. When pears are grown in situations subject to spring frosts, trees on tall stems have an advantage over the bush type ; individual rows of Standards can also be useful as wind breaks (see p. 67). Soil of medium depth is needed for Cordons and Dwarf Pyramids since the growth restriction required by apples is not so desirable for pears.

Plums and Damsons. The Half-Standard tree is the most satisfactory form for these fruits especially when it is intended to maintain them under arable conditions, the state most generally suited for them. With many plum varieties a drooping or spreading nature is taken by the branches, especially when the crop is being borne, rendering them, in the main, unsuitable for commercial development as bush trees because of cultivation difficulties. However, when it is intended to apply to grass management grazed by sheep, both plums and damsons when employed as an intercrop, say between cherries, are grown as Standards.

Cherries. The commercial form of tree most generally accepted for this crop is the Standard. This is because the lower branches of several varieties take on a drooping habit and it has been the usual custom to apply cherries to grass management, the grass being grazed by sheep.

A modern trend is to have shorter stemmed trees for orchards where it is intended to mow the grass rather than to graze, and the Half-Standard tree can be recommended for this type of management. In the main, Bush trees cannot be recommended except for a few of the erect or small growing trees, e.g. Governor Wood, Frogmore, Napoleon, Emperor Francis and Waterloo.

PLANTING MATERIAL.

It need hardly be stressed that well-grown and well-rooted material has a decided advantage over mediocre and poor

material. Not infrequently material that is poor at the outset remains poor, but the least that can be said against it is that it represents a loss of time to the grower.

Specifications. All specifications should give the name of the variety required and usually the age and the stage of development (for recommended varieties see pp. 56–60). Specifications for tree fruits should also include rootstock name or type number (for particulars regarding rootstocks see Chapter III, the reader would be helped at this stage by familiarising himself with this Chapter).

SOFT FRUITS.

Blackberries. 1 or 2 year Rooted Tips.

Blackcurrants. 1 or 2 year Bushes (certified free from reversion (see p. 212).

Gooseberries. 2 or 3 year Bushes.

Loganberries. 1 or 2 year Rooted Tips.

Raspberries. Well-rooted Canes (certified virus free) (see p. 217).

Redcurrants. 2 or 3 year Bushes.

Strawberries. Runners (certified virus free) (see p. 219).

TREE FRUITS.

Apples. (For Cordons and Dwarf Pyramids) Feathered or non-feathered Maidens (see p. 174) on No. IX rootstock.

Pears. (For Cordons) Maidens on Quince A, B or C rootstocks.

Apples. (For Bush trees) (i.e. trees with a short stem 1–3 feet high).

In the case of feathered or non-feathered Maidens or 1–2 year Headed trees (i.e. trees with partially formed heads) on rootstocks Nos. IX, VII, II, I or XVI the length of stem required should be stated for Headed trees and the minimum height for Maiden trees should be 30 inches.

Pears. (For Bush trees) : Maidens or 1–2 year Headed trees on rootstocks Quince A or B are required except for incompatible sorts which should not be worked direct on to Quince (see p. 82). For incompatible sorts either double worked trees or Thorny Pear rootstocks are required. The length of stem required should be stated in the case of Headed trees and the minimum height for Maiden trees should be 27 inches. It is preferable to have certain varieties on the Quince C rootstock (see p. 88).

Apples. (For Half-Standards and Standards) : Two year old

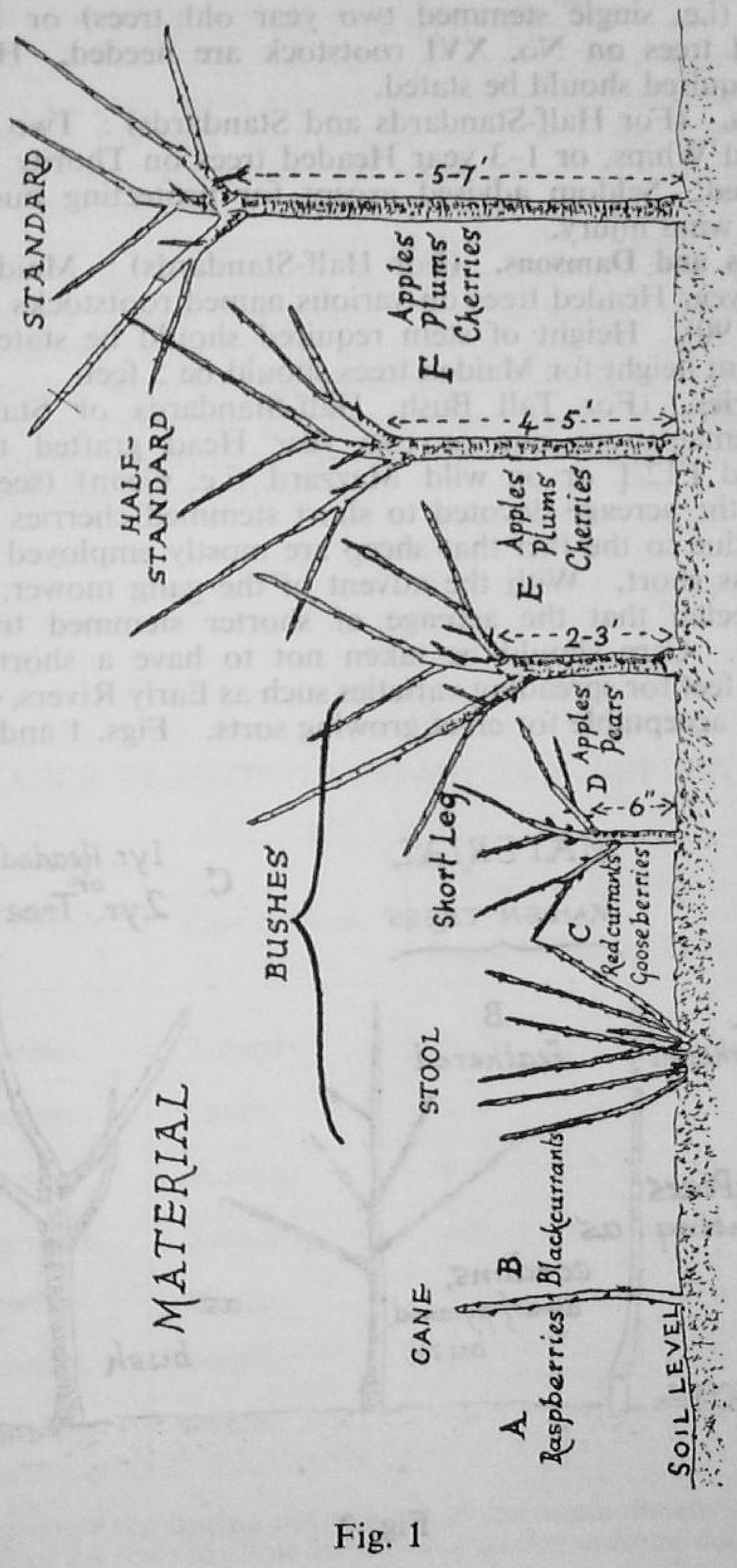
MATERIAL
STANDARD
5-7'
F Apples Plums Cherries
HALF-STANDARD
4-5'
E Apples Plums Cherries
BUSHES
2-3'
Short Leg
D Apples Pears
6"
STOOL
C Redcurrants Gooseberries
CANE
B Blackcurrants
A Raspberries
SOIL LEVEL

Fig. 1

Whips (i.e. single stemmed two year old trees) or 1–3 year Headed trees on No. XVI rootstock are needed. Height of stem required should be stated.

Pears. (For Half-Standards and Standards) : Two or three year old Whips, or 1–3 year Headed trees on Thorny Pear are employed. Seldom advised except for protecting bush pears against wind injury.

Plums and Damsons. (For Half-Standards) : Maiden trees or 1–2 year Headed trees on various named rootstocks are used (see p. 90). Height of stem required should be stated. The minimum height for Maiden trees should be 5 feet.

Cherries. (For Tall Bush, Half-Standards or Standards : Requirements are one or two year Head grafted trees on Mazzard F12/1 or on wild Mazzard (i.e. Gean) (see p. 91). As yet the acreage devoted to short stemmed cherries is small chiefly due to the fact that sheep are mostly employed to keep the grass short. With the advent of the gang mower, it is to be expected that the acreage of shorter stemmed trees will increase. Care should be taken not to have a shorter stem than 4½ feet for spreading varieties such as Early Rivers, whereas 3 feet is acceptable for erect growing sorts. Figs. 1 and 2.

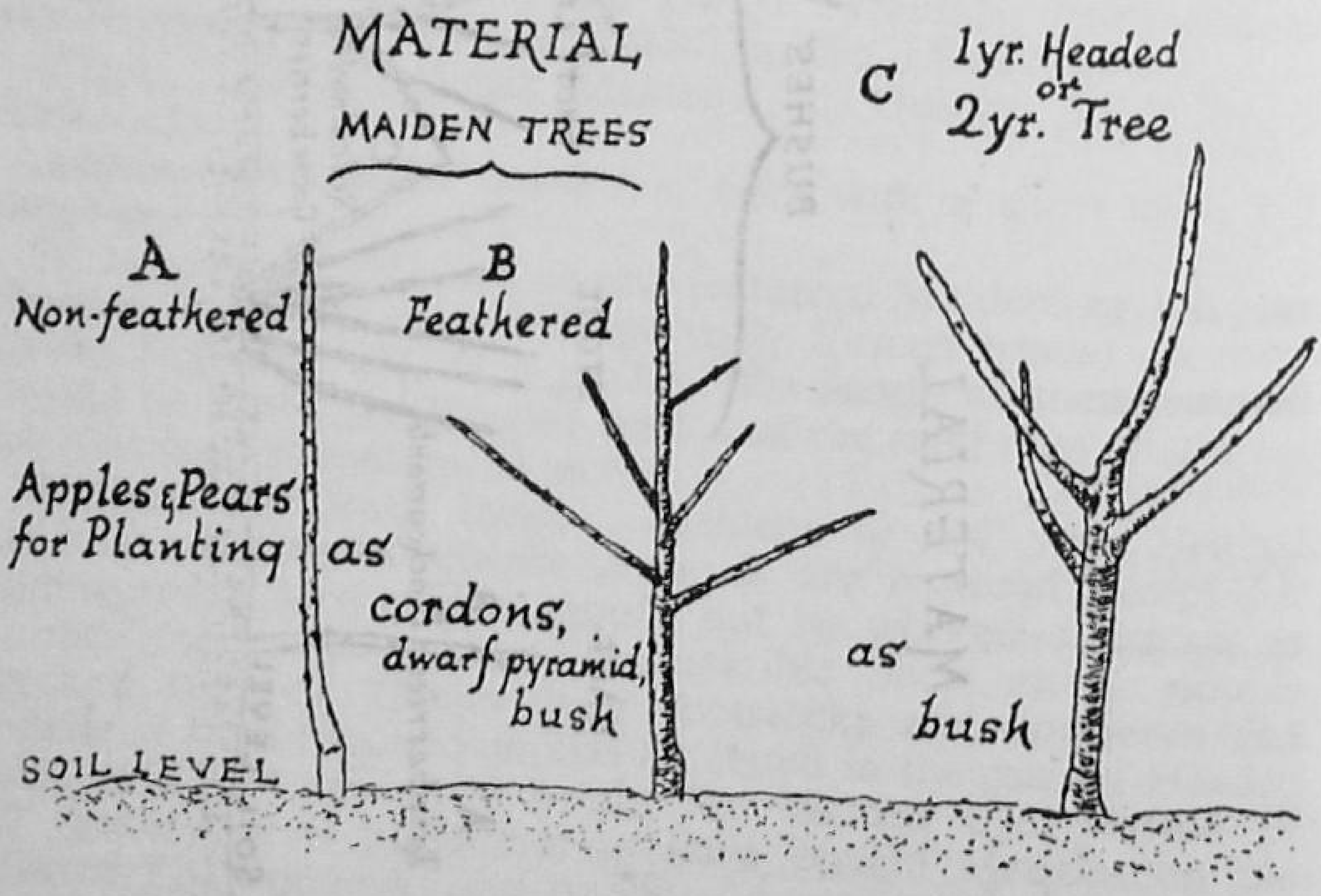

Fig. 2

PLANTING DISTANCES.

The suggestions made below regarding suitable distances at which the various fruits should be planted are based on what is considered the best commercial practice. Departures from these suggestions are admissible when based on the particular needs of soil conditions or of tractors and cultivators. Different varieties even of the same sort of fruit differ considerably in size; this is due principally to differences of rootstock, soil and inherent varietal differences. It is necessary, therefore, to give a planting range on the assumption that the smaller more erect growing sorts will be given the closer planting distances. Furthermore, the closer planting distances may be chosen even for the bigger growing sorts when they are planted under soil conditions that must restrict size.

SUITABLE PLANTING DISTANCES (SOFT FRUITS).

Kind of Fruit.	*Type or Form.*	*Planting Distance in Feet.*			
		Rows.	*Plants.*	*Bushes.*	*Stools.*
Strawberries.	Runners.	2½–3	1–1½	—	—
Raspberries.	Canes.	6–8	1–2	—	—
***Redcurrants.**	Bushes.	6–8	—	4	—
***Blackcurrants.**	Bushes.	6–9	—	4	—
Gooseberries.	Bushes.	6–8	—	6–8	—
Loganberries.	Stools.	6	—	—	6–9
Blackberries.	Stools.	6	—	—	9–12

* Sometimes the bushes are planted at the same distance apart as the width of the rows to allow for two-way tractor or horse cultivations.

SUITABLE PLANTING DISTANCES (TREE FRUITS).

Kind of Fruit.	*Type or Form.*	*Planting Distance in Feet.*	
		Rows.	*Trees.*
Apples.	Cordons. Dwarf Pyramids. Trees on Type IX Root-stock.	6–9	4–6
,, (for *Quincunx and for Square plants).	Bush (Planting distance Group I, p. 57).	18–24	18–24
,, (for rectangular plant).	Bush (Planting distance Group I, p. 57).	22½–24	15–18
,,	Bush (Planting distance Group III, p. 57).	27–40	27–40
,,	Half-Standard (Planting distance Group II, p. 57).	21–30	21–30
,,	Half-Standard (Planting distance Group III, p. 57).	27–40	27–40
Pears.	Cordons.	6–9	4–6
,, (for Quincunx and for Square plants).	Bush.	15–21	15–21
,, (for rectangular plant).	Bush.	18–22½	12–15
Plums.	Half-Standard (Planting distance Group IV, p. 58).	18–24	18–24
,,	Half-Standard (Planting distance Group V, p. 59).	24–30	24–30
Cherries.	Tall Bush, Half-Standards and Standards.	30–48	30–48

* The terms Quincunx, Square and Rectangular plants will be described under Planting Methods (see p. 53).

NOTE: Varieties are grouped according to the planting distance they require. Readers will find that on page 57 planting distance group numbers are given for the varieties recommended for planting.

PLANTING METHODS.

In general tree fruits are planted on what is commonly called the " Square " system. This implies that the rows and the trees in the rows are at equal distances apart. The trees of one row are held directly opposite the trees in the next, so that a square is formed by two consecutive trees in one row and the two nearest neighbouring trees in the next. A square plant has then one tree at each corner of the square formed by them; when a tree is also planted in the centre of the square, the term " Quincunx " is used.

For a plant of permanent trees the square plant is a good one. In order, however, to put orchard space to good use during infancy, it is a common practice to plant twice as many trees as will be ultimately required and to dispense with one-half of them when conditions of orchard space and general management demand. When such a course is followed the " Quincunx " plant should be favoured for planting in the first instance since when one-half of the trees is dispensed with, a square plant is then obtained for the permanent trees (see Diagram p. 55). Supposing a start is made with a square plant the removal of one-half of the trees produces the quincunx pattern for the permanent trees. The change over from one form of plant to another inevitably alters the directions in which cultivations proceed. In view of this, the direction of tree rows should be determined by the permanent trees. The best direction for tree rows when other conditions satisfy is North–South, although it may be necessary to modify this in relation to the shape of the field, the gradient, or other factors. It is unsatisfactory if as a result of faulty planning, the permanent layout provides less convenient directions for cultural management than were provided by the temporary trees. Hence it is a sound policy to plan to secure for the permanent trees the maximum benefits of cultural management.

A system which could be conveniently called the " Rectangular " system has much for commendation especially to growers who intend to employ mobile spraying outfits (see p. 204). It has not yet been widely adopted but there is an increasing tendency to provide for mobility in an orchard; and it is naturally desirable not to reduce the crop yield. Mobility for spraying, harvesting and cultivations means that adequate space is required between the rows. The provision of wide distances in the rows and between the rows means that several years must elapse before there are effective crops. The acceptance of a closer spacing in the rows than between the

rows would provide for ease of management and reduce the period of waiting for a productive crop. For instance, a suitable spacing for a permanent plant with bush dessert apples of the Cox type under soil conditions likely to give rise to good-sized trees would be 24 feet by 18 feet. A suitable planting distance where alternate rows are planted for a temporary period would be 22½ feet by 15 feet. The extra 7 feet 6 inches in the wide row will give ample distance for spraying, harvesting and cultivations for several years. Once trees tend to become close in the 22 feet 6 inch direction, a 30 feet row space can be provided by eliminating alternate rows in the 15 feet direction ; thus leaving the plant 22 feet 6 inches by 30 feet.

VARIETIES FOR COMMERCIAL PLANTING.

In the writer's opinion a fruit grower should plant as few varieties as possible to provide a suitable succession for labour (see p. 40) and the trees should be only of the best of the accepted commercial varieties. Such varieties grown in quantity offer much better market possibilities than several varieties in small quantities. Nevertheless, some growers succeed with varieties that do not meet with general acceptance and this success is due to specialist treatment or to local conditions that suit the variety. Growers should be wary of committing any considerable acreage to new varieties until they have reasonable assurance that they possess merits superior to those already of repute. There is, however, much to be said for small scale trials of new, promising varieties. Raspberries, however, appear to be subject to fairly rapid deterioration and varieties that are the best choice for one decade can seldom be favoured for the next. Growers committed to this crop should be continually on the look out for new introductions of outstanding commercial merit in order to take advantage of the introduction before deterioration sets in. Usually the first planting of a relatively new raspberry variety has the longest and most productive life.

In mentioning the varieties that meet with general acceptance no attempt is made to describe their characters but the cropping season whether early, mid-season, or late, and the category whether culinary or dessert are denoted. In the case of tree fruits, information is also given about the flowering season. Varieties of outstanding merit are marked with an asterisk *). Varieties suitable for growing as Cordons and Dwarf Pyramids are indicated with a dagger (†).

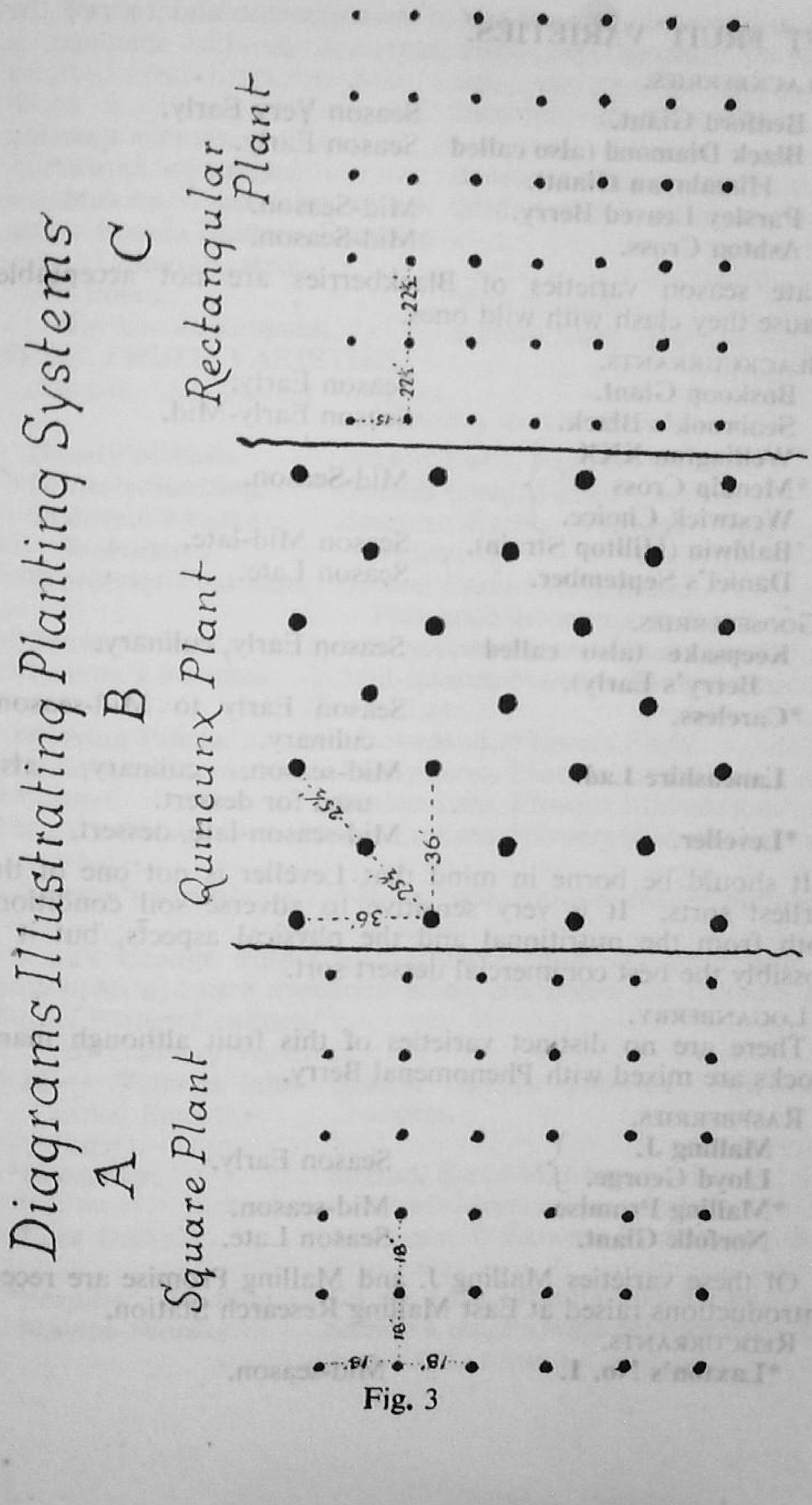
Diagrams Illustrating Planting Systems
A
Square Plant
B
Quincunx Plant
C
Rectangular Plant
18
36

Fig. 3

SOFT FRUIT VARIETIES.

BLACKBERRIES.

Bedford Giant.	Season Very Early.
Black Diamond (also called Himalayan Giant).	Season Early.
Parsley Leaved Berry.	Mid-Season.
Ashton Cross.	Mid-Season.

Late season varieties of Blackberries are not acceptable because they clash with wild ones.

BLACKCURRANTS.

Boskoop Giant.	Season Early.
Seabrook's Black.	Season Early-Mid.
***Wellington XXX**	Mid-Season.
***Mendip Cross**	Mid-Season.
Westwick Choice.	Mid-Season.
***Baldwin (Hilltop Strain).**	Season Mid-late.
Daniel's September.	Season Late.

GOOSEBERRIES.

Keepsake (also called Berry's Early).	Season Early, culinary.
***Careless.**	Season Early to Mid-season, culinary.
Lancashire Lad.	Mid-season, culinary, also used for dessert.
***Leveller.**	Mid-season-late, dessert.

It should be borne in mind that Leveller is not one of the earliest sorts. It is very sensitive to adverse soil conditions both from the nutritional and the physical aspects, but it is possibly the best commercial dessert sort.

LOGANBERRY.

There are no distinct varieties of this fruit although many stocks are mixed with Phenomenal Berry.

RASPBERRIES.

Malling J.	Season Early.
Lloyd George.	Season Early.
***Malling Promise**	Mid-season.
Norfolk Giant.	Season Late.

Of these varieties Malling J. and Malling Promise are recent introductions raised at East Malling Research Station.

REDCURRANTS.

***Laxton's No. 1.**	Mid-season.

Fay's Prolific.	Mid-season. Some difficulty is often experienced in securing this variety free from admixture with other sorts.

STRAWBERRIES.

***Royal Sovereign.**	Season Early.
Huxley Giant (also called Brenda Gautrey, Evesham Unknown, etc.).	Mid-season.
***Climax.**	Season Late.
Tardive de Leopold.	Season Late.

TREE FRUIT VARIETIES.

APPLES. (*i*) *Dessert Varieties.*

		Planting Distance Group (see page 52)
Beauty of Bath.	Season Early, Flowers Early.	I.
Miller's Seedling.	Season Early, Flowers Early.	I.
Tydeman's Early Worcester.	Season Early, Flowers Mid-season.	I.
***Worcester Pearmain.**	Season Early-Mid-season. Flowers Mid-season to Late.	I.
†James Grieve.	Mid-season, Flowers Mid-season.	I.
†Laxton's Fortune.	Mid-season, Flowers, Mid-season to Late.	I.
†Ribston Pippin.	Mid-season, Flowers Early.	I.
†Lord Lambourne.	Mid-season, Flowers Early.	I.
†*Sunset.	Season Late, Flowers Mid-season.	I.
†*Cox's Orange Pippin.	Season Late, Flowers Mid-season.	I.
Laxton's Superb.	Season Late, Flowers Mid-season to Late.	I.

Cox's Orange Pippin and Sunset should for preference be grown on a dwarf rootstock when employed for Cordon and Dwarf Pyramid culture.

(*ii*) *Culinary Varieties.*

Early Victoria (also called Emneth Early).	Season Early, Flowers Mid-season.	I.
***Grenadier.**	Season Early-Mid-season, Flowers Mid-season.	II.
Lord Derby.	Mid-season, Flowers Mid-season to Late.	II.
***Bramley's Seedling.**	Season Late, Flowers Mid-season.	III.
Newton Wonder.	Season Late, Flowers Mid-season to Late.	III.

King Edward VII.	Season Late, Flowers Late.	II.
Crawley Beauty.	(also used for dessert), Season Late, Flowers Very Late.	II.

PEARS.

Clapp's Favourite.	Season Early, Flowers Late.
†*Laxton's Superb.	Season Early, Flowers Mid-season to Late.
†Dr. Jules Guyot.	Season Early, Flowers Mid-season to Late.
†*Williams' Bon Chrétien.	Mid-season, Flowers Early.
Triomphe de Vienne.	Mid-season Flowers, Early to Mid-season.
†Fertility.	Mid-season, Flowers Late.
†Durondeau.	Season Late, Flowers Early.
†Beurre Bedford.	Season Late, Flowers Early.
Beurre Hardy.	Mid-season to Late, Flowers Late.
†*Bristol Cross.	Mid-season to Late, Flowers Mid-season.
†*Conference.	Season Late, Flowers Mid-season.
Doyenne du Comice.	Season Late, Flowers Late.

PLUMS.		Planting Distance Group (see page 52)
*Early Laxton.	Season Early, Flowers Early. Dessert and Culinary.	IV.
*Czar.	Season Early, Flowers Late. Culinary.	IV.
Belle de Louvain.	Season Early-Mid-season, Flowers Late. Culinary.	IV.
*Victoria.	Mid-season, Flowers Mid-season. Dessert and Culinary.	IV.
Pershore Yellow Egg.	Mid-season, Flowers Late. Culinary.	IV.
Giant Prune.	Season Late, Flowers Mid-season. Culinary.	IV.
Monarch.	Season Late, Flowers Early. Culinary.	V.
*Warwickshire Drooper.	Season Late, Flowers Early. Culinary.	IV.
Pond's Seedling.	Season Late, Flowers Late. Culinary.	V.
*Marjorie's Seedling.	Season Late, Flowers Late. Culinary and Dessert.	V.

The chief merit of Early Laxton plum is its earliness, attractive appearance and acceptable flavour, the chief drawback is its susceptibility to Bacterial Canker (see p. 236). Many may criticize the selection of Czar as a variety of exceptional merit. The earliness of this variety, the regularity with which it crops and its resistance to frost are the main features that commend it. It should also be borne in mind that there has been a tendency of recent years to plant heavily with late varieties and to neglect the early cropping sorts. Both Czar and Victoria are subject to the Silver Leaf disease (see p. 234) and these like Early Laxton are subject to Bacterial Canker.

Gages.		Planting Distance Group (see page 52)
Early Transparent.	Season Early, Flowers Early.	V.
***Oullin's Golden.**	Season Early, Flowers Late.	V.
Denniston's Superb.	Mid-season, Flowers Early.	V.
***Cambridge.**	Mid-season, Flowers Late.	V.
Laxton's	Mid-season, Flowers Late	V.

Only Gages with a good cropping record have been included in the above list.

Damsons.		
Farleigh (also called Cluster).	Season Late, Flowers Late.	V.
***Shropshire Prune.**	Season Late, Flowers Late.	V.

Cherries.	
***Early Rivers.**	Season Early, Flowers Early-Mid-season.
Knight's Early Black (also called Circassian).	Season Early, Flowers Mid-season–Late.
Early Amber.	Season Early, Flowers Early.
Governor Wood.	Mid-season, Flowers Late.
Nutberry Black.	Mid-season, Flowers Early.
***Roundel.**	Mid-season, Flowers Mid-season.
Frogmore Early Bigarreau.	Mid-season, Flowers Late.
***Noir de Guben.**	Mid-season, Flowers Early.
***Amber Heart (also called Kentish Bigarreau).**	Mid-season, Flowers Late.
***Bigarreau Napoleon.**	Season Late, Flowers Late.

***Bradbourne Black.**	Season Late, Flowers Late.
***Gaucher.**	Season Late, Flowers Mid-season-Late.
American Black Republic.	Season Late, Flowers Mid-season-Late.
Emperor Francis.	Season Late, Flowers Early-Mid-season.
***Florence.**	Season Late, Flowers Late.

The successful establishment of a cherry orchard is being rendered increasingly difficult due to the disease Bacterial Canker (see p. 239). The varieties marked with an asterisk, with the exception of Bigarreau Napoleon and Bradbourne Black, are relatively resistant to this disease and most of them are markedly so. The very superior qualities of the Napoleon cherry entitles it to a place in a list of selected varieties although some responsible growers are rather less inclined to include it in present day plantings than was the case a few years ago. This fact should serve to emphasize the necessity of planting only healthy trees.

CONSIDERATIONS AFFECTING NATURE OF PLANTING PLANS.

With soft fruits the chief factor affecting the planting distance is the size to which the various kinds and varieties grow. Secondly, the form of tractor and cultivator to be employed influence a decision because relative ease of management is of fundamental importance, it being better to plant a little wider than necessary rather than suffer, early in the life of a plantation, the many disadvantages of having plantings too close. When fruits are planted nearer together in the rows than between, or where they are planted to form a continuous row e.g. raspberries, blackberries, the rows should, where practicable, run in a North–South direction, because this reduces to a bare minimum the shade effect of one row upon the next. Nevertheless, this ideal is not always practicable ; for instance, on some sites it may be preferable to put up with more shade rather than commit oneself to the difficulties in cultivation which short rows introduce (see p. 53).

Some varieties of bush fruit when fully grown make bigger bushes than others, so that it is unwise to plant all varieties of the same kind of fruit at equal distances between the bushes. With gooseberries, the variety Keepsake makes a larger bush than the other three recommended sorts (see p. 56) and should not be planted at less than 7 feet apart and for preference the

square plant should be adopted (see pp. 52–55). The varieties Careless and Lancashire Lad do not make such large bushes as Keepsake and they are erect growing sorts ; whereas Leveller which makes only a small bush has a very spreading habit. A suitable planting distance for these sorts is 6 by 6 feet.

Blackcurrant varieties such as Boskoop Giant, Wellington XXX, Mendip Cross which make large bushes and have a spreading habit need about 9 feet between the rows, whereas large growing erect sorts such as Seabrook's Black and Westwick Choice only require about 7½ feet for satisfactory management. The varieties Baldwin and Daniel's September seldom need be given more than 6 feet between the rows since they form relatively small bushes (see p. 51).

Of the Blackberry varieties, Black Diamond needs the maximum distance of 12 feet in the rows and the smaller growing Parsley Leaved Berry, Ashton Cross and Bedfordshire Giant may be planted at 9 feet. Since the canes of this fruit are trained to supports, the distance between the rows can be the same for all varieties, viz. 6 feet (see p. 51).

Suitable planting distances for tree fruits as for soft fruits are governed by the size to which the trees can be expected to grow under various soil conditions. The decision is complicated by the fact that tree fruits are grown on different kinds of rootstocks (see pp. 48, 80). Most tree fruits are propagated by budding or grafting and the portion below the bud or graft-union including the root is called the " Rootstock." With apples and, to a less extent, with pears and plums, the ultimate size to which a tree will grow is greatly influenced by the rootstock and this, together with variety and soil conditions, will affect the choice of planting distance.

With tree fruits it is often desirable to have more than one variety in the same plantation. If such varieties are to be planted in blocks at the same planting distance, it is desirable to choose sorts on rootstocks that form trees of similar size. When large growing trees are planted it is necessary to have them at wide distances apart and since they will take several years before they need all the space allocated to them, smaller growing trees that crop relatively early in life are often planted in between as a temporary plant, to be scrapped as, and when the bigger-growing permanent trees require all the space. With precocious varieties of apples and pears it is preferable, within reason, to plant too near together in the first instance, than too far apart, although this cannot be said to apply to plums and cherries. Most varieties of apples and pears except the sorts

that make big trees, can be expected to yield productive crops within 4–6 years after planting, which is several years before they can be regarded as fully grown. By planting trees closer than they are ultimately required, several crops can be obtained from them before they become too close. Once they are too close, the scrapping (i.e. grubbing) of alternate trees provides a wider plant without reducing productiveness for more than one or two years (see p. 250). A system such as this is designed to ensure the maximum productiveness within the shortest time and for the longest period. The choice of very wide planting distances in the first instance is a factor that initially delays productiveness and in the event of the trees becoming too close during the course of years, the grubbing of alternate trees then leaves excessive distances between trees and a consequential loss of productiveness. For instance, if Cox's Orange Pippin are planted on the square system at 18 by 18 feet and alternates are grubbed, the resulting distance is approximately 24½ feet by 24½ feet whereas a choice of 21 feet by 21 feet would result in distances of 30 feet by 30 feet apart, which, under most conditions, is too wide for this variety.

Of the apple varieties, Bramley's Seedling and Newton Wonder require about twice the planting distance when grown on similar rootstocks and under similar soil conditions, as all the remaining varieties in the list of recommended sorts with the exception of Laxton Superb, Lord Derby and Crawley Beauty which require distances rather less than three-quarters of that for Bramley (see p. 52).

Most of the recommended pear varieties approximate in their planting requirements to those of bush apples of the Cox type as far as distance is concerned. If anything, the distance should be a little closer than wider. Varieties such as Clapps Favourite and Doyenne du Comice require about 1½ times the planting distance of the other sorts, say 22 feet as against 15 feet (see p. 52).

There are big differences in the size of fully grown plum varieties. The largest trees, for which the widest distances are needed, include the gages, varieties such as Belle de Louvain, Monarch and Marjorie's Seedling, and the recommended Damsons. The varieties Early Laxton and Giant Prune only need one-half of the distance required by the largest growing sorts whereas Czar, Victoria, Pershore Yellow Egg and Warwickshire Drooper need three-quarters (see p. 52).

Since a choice of plum varieties may include some of the large growing sorts and some of the smaller growing sorts in the

same plant, it is preferable either to have wider rows for the large growing sorts and so afford them sufficient room in the cross row direction, or to have them planted wide enough to take an interplant of the smaller growing sorts.

Although there are considerable differences in the size of the various cherry varieties when they are fully grown, the planting distances are determined by the largest growing sorts, since considerable mixing of varieties is necessary to provide for pollination and suitable picking succession. Most of the cherry varieties make large trees and smaller growing varieties such as Nutberry Black, Bradbourne Black, Bigarreau Napoleon and Noir de Guben may be planted between them, provided their flowering periods overlap and that they are compatible sorts as far as pollination is concerned (see p. 105). So far as is possible, it is advisable to plant varieties to provide both for pollination and succession of harvesting.

In view of the wide distance apart that cherries are planted, growers invariably plant an intercrop and plums are often chosen for the purpose. Since both cherries and plums are subject to the diseases Bacterial Canker and Silver Leaf (see pp. 234, 236) and since most plums deteriorate quickly when applied to grass, they cannot always be regarded as a good choice. With the advent of the gang-mower to cut the grass (see p. 113) in place of sheep for grazing, the interplanting of bush dessert apples is made possible because this crop is suited to grass management in soil capable of growing cherries.

With all the tree fruits, planting plans must be made to cater for satisfactory pollination. This involves mixing varieties to a limited extent and in addition to having varieties that are suitable for interpollination, they should be planted in a definite order, and respond satisfactorily to similar spray treatments and similar management, generally. The question of pollination and rootstocks are dealt with in separate chapters where recommendations will be found concerning suitable planting plans for the various tree fruits (see pp. 80, 90).

SECTION II

PREPARATION, PLANTING AND PROTECTION.

PREPARATION OF SOIL.

There are two distinct aspects of soil preparation, viz.: (i) soil cultivation and (ii) application of fertilizers and manures. The detailed treatments required by the various crops are dealt

with in the sections on Soil Cultivation (Chapter V) and Manuring of Fruit Crops (Chapter VI).

(i) **Soil Cultivation.** In general, planting out should be into clean cultivated soil, although the operation will be considerably eased if newly ploughed land is avoided and if the soil surface is reasonably level. Furthermore, since of necessity there is much treading of land that is being planted, the soil surface should be reasonably dry and crumbly (friable). At least one should endeavour to avoid planting out under wet, puddly conditions. Whereas most fruits can be planted with success as the first crop following old pasture, strawberries are likely to fail because of such pests as wireworm and leather jacket. The planting of strawberries should therefore be deferred for one or two years after the ploughing in of old pasture.

(ii) **Application of Fertilizers and Manures.** For soft fruits and in particular for strawberries, it is essential to plant out into soil that is in " good heart " (i.e. soil that has been subjected to generous husbandry, that does not lack neither organic matter nor essential mineral matter and is of a readily ameliorable physical character). Whereas preplanting application of bulky organic manures should be made for strawberries, the application may be made immediately after planting for other soft fruits ; with tree fruits it is seldom necessary or desirable to apply organic manures at the time of planting or immediately after (see pp. 129, 134).

On the mineral side, steps should be taken prior to planting to correct deficiencies where they are known to exist, particularly in respect of potassium and magnesium. When the grower does not know or is in doubt as to the mineral status he should submit a representative soil sample to the soil chemist of the Agricultural Advisory Province in which he is situated. Fruits generally are tolerant of a wide range of conditions and are known to thrive on both alkaline and acid soils, nevertheless care should be taken not to indulge in applications of lime without information as to soil conditions and the requirements of a particular crop (see p. 130).

Over-grown grassland with a considerable mat of strawy material that is being clean cultivated in preparation for planting fruit requires the application of 3–5 cwts. of an inorganic nitrogen fertilizer such as " Nitro-Chalk " or sulphate of ammonia. If this is not done the strawy material is likely to take a long time to rot down and may contribute to a serious temporary nitrogen deficiency (see p. 122).

PROTECTION AGAINST WIND, LIVESTOCK AND RABBITS.

Considerable damage can be done to trees by high winds, particularly by autumn gales, and loss of crop may be sustained. For young trees it is generally advisable to provide individual supports which usually take the form of tying each tree to a substantial stake that has been driven firmly in the soil. Staking is a post-planting operation and is dealt with below (see pp. 74–79).

Fruit which neighbours land that is used for grazing livestock or folding sheep needs adequate protection. This entails the provision of a fence or hedge which is proof against straying animals. Apples and pears normally require additional protection against rabbits and hares and this entails the provision of a wire netting fence around the entire site or of wire netting guards around each tree. Rabbit smears, designed to act as repellants are sold for painting onto the stems of trees, but these cannot be regarded as satisfactory for very young trees because certain proprietary repellants effective against rabbits are liable to stunt the development of young trees with tender bark. There is much to be said for the wire netting fence surrounding a field, although care must be taken to keep gates shut and frequent inspection of trees is necessary during hard weather. Individual wire guards can be effective, although they have disadvantages, for instance, access right up to the tree stem is hindered and this makes for cultivation difficulties. Furthermore, individual guards cannot be employed for short stemmed bush trees, since the protection afforded is not adequate when the stem is less than 27 inches high. Individual tree protection of the required height does, however, provide greater proof against injury than a field fence and it is essential to have it for young Half-Standard and Standard trees in grass orchards where the herbage is kept short by sheep ; otherwise considerable damage may be done by the animals. Individual tree protection usually takes the form of a tall wire netting sleeve fixed to a stake supporting the tree. If a heavy gauge small mesh (say 1-inch) wire netting is used, no further support is needed, but otherwise a single strand of barbed wire should be wrapped two or three times spirally round the sleeve.

A wire fence is supported by intermediate and key straining posts which stand about 5–6 feet above soil level. The height of the wire netting should at least be 5 feet with 4 feet above the soil, and 1 foot embedded in the soil, to fan outwards away

from the enclosure. The portion above ground should be fastened by wiring to stout galvanized wire strands that have been strained and fixed to the posts. The wire netting should be of 1 inch mesh and of heavy gauge. At the top of the fence two barbed wire strands should be fixed, one within a few inches of the wire netting and the other about 6 inches higher, at the extreme top of the posts. When this or a similar form of protection is adopted, it is also essential to ensure that the gates leading into the enclosure are made rabbit-proof and that it is the habit of all users to shut them.

Since planting operations proceed during the winter months when damage by rabbits and hares is most likely to occur, it is necessary to erect a suitable enclosure before planting operations are undertaken, unless the individual method of tree protection is followed ; in that case, the wire sleeves may be put round each tree immediately after planting or around all the newly planted trees after each day's planting.

Individual wire guards for bush trees, are made by cutting 27-inch lengths from a roll of wire netting 3 feet wide. As with the wire fence a small 1-inch mesh is needed. From the strips of wire netting 27-inch sleeves can be made and the two edges of a sleeve can then be fixed to a stake driven in by the side of each tree. The stake also forms a tree support to which the tree is tied. When this form of protection is adopted, it is the usual custom to place a wire guard round each tree immediately after planting as a temporary measure, and the complete staking, tying and fixing of the guard is done after all the planting is finished (see p. 74).

Damage by rabbits or hares to young trees not infrequently occurs after delivery to the farm and before the trees are actually planted out in the field. The first necessary task upon receiving young trees is to "heel" them in. This is done by putting the exposed roots in a trench and covering them with soil. They should be heeled in as close together as practicable, after which they should be surrounded with wire netting. If the trees are to remain heeled in for any length of time, it is wise to set a few mouse traps because mice are often responsible for much damage especially when straw is used to protect the roots.

On exposed sites the establishment of a permanent wind screen or wind breaks is advised ; if possible it is best to plant these a few years in advance of the chosen fruit crop. The frequency and position of such screens will depend upon the contours of the planting site, and the direction from which protection is required. In the majority of cases where screens

are needed, they are to afford protection from south-westerly autumnal gales and the protection is then designed to lessen the strain upon the natural anchorage provided by the roots, and to reduce loss of crop and laceration of foliage. In some cases protection is needed against cold north-easterly winds during blossoming and so to provide more favourable conditions for pollinating insects. The minimum protection required, when any is needed at all, is the single row windbreak skirting the field boundary, on the side or sides from which injurious winds blow. Such is all that is needed for small units which, in spite of being exposed, lie reasonably flat. More than this will be required on large scale sites and those on a slope ; in such a case a single boundary windbreak may be valueless to fruit growing some little distance away or to fruit grown at higher levels. Seldom is it necessary to have windbreaks nearer than 100 yards apart except to satisfy peculiar topographical features. This much can be asserted : because one row of fruit trees, once established, affords a measure of protection for the next, trees to some extent become self protecting. Furthermore, there are strict limitations that gradient imposes upon the practicability of growing fruit on a particular site, both from the standpoint of wind injury and of soil cultivations (see p. 34).

The choice of suitable trees to serve as wind-screens is governed by the kind of fruit grown and the height of screen required. Usually the most satisfactory screen is provided by taller growing fruit trees of the same kind of fruit. Thus for plums, varieties like Kentish Bush and Blaisdon Red are favoured. For apples, Half-Standard and Standard trees of of similar varieties to those planted (but on more vigorous rootstocks) can be used with good effect. Varieties making sturdy, erect growth and furnished with thick, stiffly-held leaves, not easily lacerated by wind, e.g. Worcester Pearmain and Sunset as Half-Standards on Malling No. XVI rootstock, are especially suited as screen-rows ; and, incidentally, they may at times be employed to replace some of the pollinator rows (see p. 98). The variety Bramley Seedling will also provide good screen-rows even taller than Worcester Pearmain, but whereas it may be allowed to spread and fill the planting distance to form an effective screen in one direction, it may be necessary to prevent excessive spread in the other direction. For years, various varieties grown on Pear rootstocks (see p. 88) as Half-Standards such as Dr. Jules Guyot, Williams' bon Chrétien and Conference will form ideal screen-rows for bush orchards, although the leaves of the last named variety are

torn rather easily by high winds. The variety Doyenne du Comice will make an ideal wind-break when grown as bush trees on Quince A or B rootstocks in view of its compact, tall, erect-growing habit, although the fruit from this sort is harvested very late in the season. When choosing fruit varieties as wind-breaks care should be taken, so far as is possible, to select sorts that are both suitable and fit into the general management requirements as a whole, especially in respect of pest and disease control.

Sometimes taller-growing wind-breaks are needed than those afforded by fruit trees ; this applies more particularly to those required on field boundaries. The erect-growing Lombardy Poplar, which only requires occasional Pollarding (i.e. cutting back severely to reduce excessive height) may be favoured in preference to the widely planted Black Italian Poplar, for this latter, in view of its spreading habit of growth, requires laborious cutting every year. Where a form of screen is needed to afford protection against cold north-easterly winds, an evergreen such as *Thuya lobi* commends itself, and it may be alternated, if necessary, with Lombardy Poplar or with Larch ; the Lombardy Poplar giving a basal screen and the Larch providing a tall wind-filter. The formation of a dense basal screen where cold air could collect should be avoided.

PROTECTION AGAINST DIRT. (Strawberries).

By virtue of the fact that strawberries are liable to be splashed by soil in the event of heavy rain during the harvesting period, it is necessary to protect the fruit against this eventuality. This is done by laying clean straw (i.e. straw free of noxious weeds such as docks and thistles) to provide a mat on which the fruits will ripen. Hand application is necessary to tuck straw under the spreading fruit trusses. Normally 30 cwts. to 2 tons of straw are required per acre.

Since a commercial crop of strawberries is not borne during the first Summer after planting, no strawing is done at this stage but it is customary and of some advantage to de-blossom during the first Spring (i.e. to remove all blossom trusses).

After harvesting a strawberry crop the straw may either be raked up and carted away or rendered loose and burnt *in situ*. In the event of the latter course being adopted quick-burning conditions are essential, and so is control over the operation. Of recent years some growers have left the straw and have been successful in cultivating with a ridging plough after harvesting. This may be even more practicable in the event of the straw

being " chaffed " (i.e. cut up into small pieces) in the first instance. In any case, the retention of straw renders necessary the application of additional nitrogen (see p. 122).

MARKING OUT OPERATIONS.

It will no doubt be appreciated that the various fruits are planted in straight rows to facilitate the normal cultural operations. With most fruits this applies to both the up- and the down-row direction as well as to the cross-row direction. The most satisfactory lay-out of an orchard that provides for this two-way ease of cultural management, is one where the cross-rows run at right angles to the up- and down-rows. Thus trees in one row are planted opposite to trees in the next row.

Haphazard planting will not suffice to secure an arrangement of this description and it can only be done if a site is marked out prior to planting. Marking out implies that the position of planting is determined by measurement and it is usually indicated by sticks pushed into the soil.

First of all it should be borne in mind during the marking out operations that sufficient room at the field boundaries, or so called " headlands " must be left to allow for the cartage of fruit and the turning of tractors with implements. Although only small trees are planted, the basis of calculation is the fully-grown tree or bush. Assuming that 12 feet is sufficient turning room and cartage width, this figure should be added to one-half the spread-measurement that the trees or bushes will occupy when fully grown. Thus when trees are to be spaced at a 24 feet by 24 feet plant on the assumption that the ultimate spread of each tree will be 20 feet, a headland of 22 feet will be required (i.e. 10 feet plus 12 feet).

A simple method of marking out for tree or bush fruit is to fix two key sighting posts. These posts are fixed to stand erect one at one end and the other at the other end of the first row. The longest and straightest field boundary is usually the best starting point after allowance has been made for the headlands, and this is determined by measuring from the boundary. Once the two key sighting posts are fixed, other short sticks will be fixed at frequent intervals in between. They are fixed after sighting them, to fall in straight line with the two key sighting posts. Following this, a measuring chain or line is used to mark with small sticks the exact positions where trees or bushes are to be planted (for recommended planting-distances see pp. 51, 52). After this, it is necessary to mark out two cross

rows, one near to each end of the first row that is now already marked out. Both cross-rows should be at right angles to this first row. There are several ways of making certain that they are formed at right angles to it. The usual procedure involves the use of a long measuring tape or chain and three sighting posts. Near to one end of the first row one of the small sticks that marks the position for a tree or bush is removed and in its place, one of the three sighting posts is fixed. On each side of this sighting post, a position along the first row is chosen to fix each end of the measuring chain or tape. Each position chosen should be an equal distance, say about 10–18 feet from the sighting post and one end of the measuring chain or tape should be fixed or held at one of them and the other end at the other. Next, the chain or tape is held in the dead centre and pulled taut by walking out into the field away from the first row. At this point, which will be at right angles to the first row, the second sighting post is fixed. The third sighting post should then be fixed by sighting it in line with the first and second sighting posts at the other side of the field, or as far distant as allows for good sighting. The second right angle at the other end of the first row is obtained by following a similar procedure and the two cross-rows are formed by marking out with sighting canes and then with small canes as described for the first row. In this way positions for each row are established, and all that remains is first to sight a few sticks in line for every row, in turn, and then to measure, and mark with small sticks, the positions for planting.

Marking out strawberries is best done with the aid of a marker drawn by horse or tractor as is common for certain green crops. The teeth of the marker set at the correct distances apart disturb the soil sufficiently to indicate the position of the rows. This method can also be employed for marking raspberry, loganberry, blackberry, Cordon and Dwarf Pyramid rows and some have used it successfully for other fruits, including bush tree fruits, by marking both down the rows and across the rows.

Supposing trees or bushes are to be planted at wider distances in one direction than the other, or are held tall by supports as is common with such fruits as raspberries, blackberries and loganberries, the rows should run in a north to south direction, if conditions of cultivation permit, and this particularly applies to Cordons and Dwarf Pyramids. A north to south direction of rows ensures that no more than the minimum shade is cast by one row upon the next. An east to west direction will be

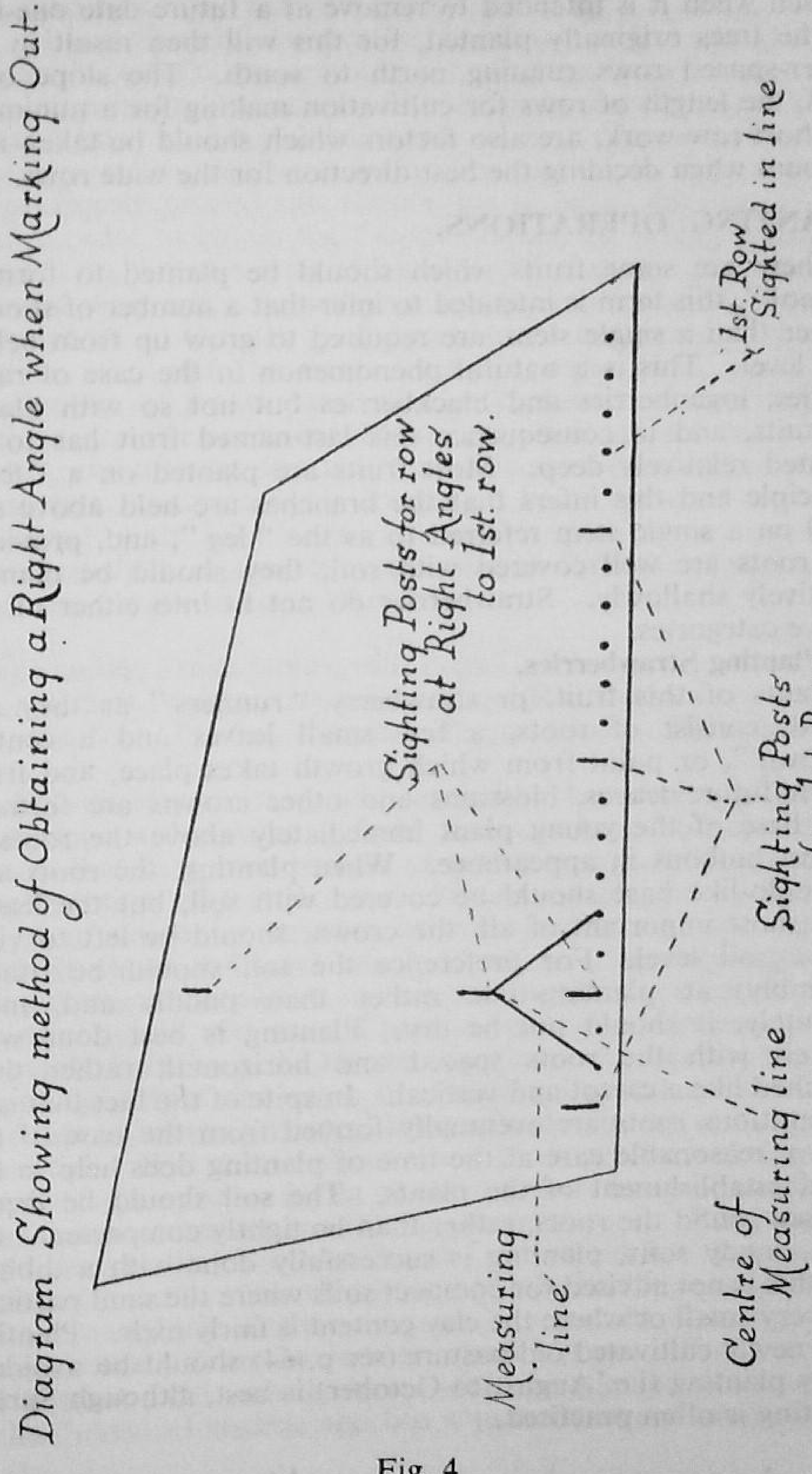
Diagram Showing method of Obtaining a Right Angle when Marking Out.
Sighting Posts for row at Right Angles to 1st. row.
1st Row Sighted in line
Sighting Posts for 1st Row
Measuring line
Centre of Measuring line

Fig. 4

chosen when it is intended to remove at a future date one-half of the trees originally planted, for this will then result in the wider-spaced rows running north to south. The slope of a field, the length of rows for cultivation making for a minimum of short-row work, are also factors which should be taken into account when deciding the best direction for the wide rows.

PLANTING OPERATIONS.

There are some fruits which should be planted to form a " stool ", this term is intended to infer that a number of shoots, rather than a single stem, are required to grow up from below soil level. This is a natural phenomenon in the case of raspberries, loganberries and blackberries but not so with black-currants, and in consequence this last-named fruit has to be planted relatively deep. Most fruits are planted on a " leg " principle and this infers that the branches are held above soil level on a single stem referred to as the " leg ", and, provided the roots are well covered with soil, they should be planted relatively shallowly. Strawberries do not fit into either of the above categories.

(i) Planting Strawberries.

Plants of this fruit, or strawberry " runners " as they are called, consist of roots, a few small leaves and a central " crown ", or point from which growth takes place, and from which future leaves, blossoms and other crowns are formed. The base of the young plant immediately above the roots is almost bulbous in appearance. When planting, the roots and the bulb-like base should be covered with soil, but the leaves and, most important of all, the crown, should be left to view above soil level. For preference the soil should be friable (crumbly) at planting-time rather than puddly and, most definitely, it should not be dry. Planting is best done with trowels with the roots spaced and horizontal, rather than bunched like a carrot and vertical. In spite of the fact that new adventitious roots are eventually formed from the base of the crown, reasonable care at the time of planting does help in the rapid establishment of the plants. The soil should be firmly pressed round the roots, rather than be tightly compacted. On light, sandy soils, planting is successfully done with a dibber, but this is not advised for compact soils where the sand particles are very small or where the clay content is fairly high. Planting into newly cultivated old pasture (see p. 64) should be avoided. Early planting (i.e. August to October) is best, although Spring planting is often practised.

(ii) Planting Fruits Grown as Stools.

Blackcurrants, Raspberries, Loganberries and Blackberries.

Spades or forks are required for planting these fruits and, as with strawberries, crumbly soil conditions are to be preferred. Blackcurrant bushes consist of one or more one-year old shoots that have grown out from the original cutting or from the base of previously pruned side shoots (see p. 263). In view of this, and in order to obtain the " stool " effect, the bushes should be planted so that the base of each of the one-year old shoots is covered with soil. Raspberries, Loganberries and Blackberries are planted so that the roots are about 6 inches below the soil surface, thus all the basal " stool " buds, from which the production of future canes can be expected are covered with soil. Once the roots are covered, the soil should be trodden firmly, and afterwards a covering of loose soil should be placed over that compacted by treading. Some growers who are favoured with light soils, successfully plant cane fruits by standing them in the base of a plough furrow before turning the next furrow to cover the roots.

(iii) Planting Fruits Grown with Legs.

(a) **Soft Fruits.** Gooseberries and Redcurrants.

(b) **Tree Fruits.** Apples, Pears, Plums, Damsons and Cherries.

As with blackcurrants and similarly grown fruits, planting is best done with spades or forks under crumbly soil conditions. Fruits that have been budded or grafted (see p. 265) near to the root portion of the rootstock, should be planted so that the point of union, or junction between variety and rootstock, is slightly above soil level, say 2–3 inches. It is very important to pay special attention to this with apple varieties on dwarf rootstocks and with several pear varieties on Quince rootstocks (notably Fertility and Doyenne du Comice). Serious management difficulties and other disadvantages are likely to arise as a result of bringing the soil into contact with the stem of these varieties. This comes about when roots are formed from the stem of the variety, for in course of time this will cancel out the specific character imparted by the rootstock. Roots formed by a variety that has been budded or grafted are spoken of as " Scion " roots. Cherries are usually grafted high on the stem of the rootstock so that no roots are formed from the scion itself, but only from the stock on which it grows. For preference redcurrants and gooseberries should be planted with a short " leg ", say 3–6 inches, and this stands above soil level. When

the "leg" is tall for these fruits considerable casualties are likely to occur from cultivating operations and the bushes are prone to be weakly. When redcurrants and gooseberries are grown as stools, difficulties in soil-cleaning operations are experienced and much time is consumed in dealing with sucker shoots at the base of the bushes. Nevertheless, the stool habit results in a more rapid establishment of bushes and is preferable to a tall leg. With all the fruits dealt with under this heading and with those grown as stools, the planting should be firm, especially if it is done late, that is during late Winter and early Spring. For preference, planting should be done during November or December.

Holes are dug around the sticks previously fixed during the marking out operations; the sticks being removed in the process. Some make use of a planting board to make sure of getting trees in exact alignment but this is fastidious and unnecessary, if it is known that the marking stick occupied the central position of each hole. The planting is completed by placing a covering of loose soil over the top of the compacted soil.

Trees are not exactly alike and sometimes it will be wondered which way round to plant them. With budded maiden trees there is some advantage in planting so that the budded side of the rootstock is directed towards the prevailing wind, and with older trees when one side has a greater number of shoots or branches than the other, the side with the greater number should be directed towards the prevailing wind.

Systematic root pruning is not necessary when planting out young fruit trees and bushes. It is necessary to cut away roots that are broken and occasionally others that make for needless difficulties when planting.

It is usual to plant trees and bushes so that they stand erect, the only commercial exceptions being the Cordon tree, the single main stem of which is trained to grow in a sloping fashion. The Cordon tree should be planted slightly on the slope, say 10 degrees from vertical and for preference the slope should be southwards.

STAKING AND TYING; AND SUPPORTS.

Bush, Half-Standard and Standard Trees.

Most fruit trees need some support at the time of planting or soon after. Maiden trees may be left for a year, but trees that are planted with a head already formed should be supported with stake and tie during the season of planting. Stout stakes

of 2–3 inches diameter should be driven into the soil to a depth of about two feet. A single stake should be used for each tree and it should be driven in, for preference, to stand erect within 2–3 inches of the stem of the tree it is intended to support and on the south-west side. The length of the stakes will depend upon whether they are to be employed for supporting Bush, Half-Standard or Standard Trees. In general, the above-ground portion of a stake should be almost as tall as the stem of the tree it supports, but no abrasion of young branches or main stem due to chafing should be countenanced. There are other forms of staking in common usage but the one mentioned is possibly the most satisfactory whilst trees are young, before the branches have attained a size that makes for difficulty in driving in a stake to stand erect. For most trees, staking once during the life will suffice if the stakes used are of durable wood and sufficiently stout.

In the event of having to stake Bush trees that have heads a few years old, which renders it difficult to drive stakes in near the trees, it is best to drive the stake in at an angle of, say, about 60 degrees. Each stake should be driven in on the north-east side of a tree, so that it crosses the main stem and so that the top of the stake protrudes on the south-west side.

Seasoned Sweet Chestnut stakes are as satisfactory as any, and these should be pointed to facilitate their being driven into the soil. To ensure good life, they should be pointed and the pointed ends should be steeped in boiling creosote whilst in the green wood state. The stakes should be allowed to cool in the creosote to facilitate a deep penetration of the preservative. Since a stake invariably breaks, first, at or near soil level, it is very desirable that the creosote level should be above soil level.

The support is completed by tying a tree to its stake. Since it is anticipated that the trees will grow and the stem diameter increase, forms of tree-ties that do not allow for normal stem expansion should be avoided. Tree-ties should be subject, at least, to annual inspection and if necessary they should be renewed. When care of this kind is neglected it is not uncommon to find trees that have been severely checked in development if they have not actually died as a result of strangulation caused by ties becoming too tight. A method of tying that provides a form of cushion between the stake and tree will be a good safeguard against stem abrasions.

In normal times, reject cycle tyres can be obtained at very reasonable prices from the manufacturers for use as a tie material and perhaps better than these, is reject motor tyre rim

tapes. In the case of tyres, the wire rims are first removed, and care is taken to cut clean rather than ragged. The treads may be employed for trees three years old and upwards and the two walls on either side of the tread may be used for trees that are younger than this. Thus a single tyre will provide three 7-feet strips of tie material. A tyre strip or rim tape is secured to the stake with the aid of large-headed roofing or felting nails. Having secured one end, at a point near to the top of the stake stake, the strip is passed diagonally between the stake and the tree, round the tree and diagonally back to the stake. Thus the two strands cross between stake and tree to form what is commonly known as the "figure of eight" tie. Before completing the tie by nailing to the stake, the second diagonal strand may be wrapped round the first thus forming the cushion already suggested as well as giving stability to the tie. The advantage of rubber ties of this description that are strengthened by canvas is, first, that they are durable, 2–4 years, and, second, that there is sufficient elasticity about them to avoid danger from strangulation.

Various other materials can be used as tree-ties and indeed at times have to be used. One that is favoured is several strands of thick cocoa-fibre string such as is used for tying hops, but stouter. It is fixed by tying. When this material is employed, it is advisable to guard against it subsequently cutting into the stem of the tree by first wrapping a thin strip of sacking round the stem. For tall-stemmed trees, two ties should be preferred, one near to the top of the stake and the other about half-way down.

It is seldom necessary to provide supports for trees for more than 6–7 years. Apple trees in grass orchards that are grazed by sheep require further protection, in addition to the support provided by stakes and ties. Usually the protection takes the form of a tall wire netting sleeve fixed to the stake (see p. 65) and around it a strand of barbed wire is wrapped spirally.

Staking Established Trees.

Sometimes established trees require support, this especially applies to bush apples on Malling Type IX rootstock and to certain bush pears on Quince rootstocks (p. 85). For large-sized bush trees with heavy heads, the single stake is hardly adequate and added to this is the considerable difficulty of driving in a single stake near the main stem. The most suitable method to adopt is to drive in two stakes to stand erect, one on the north-west side and one on the north-east side, about 9 inches on either side of the main stem. This will bring the two

stakes about 18 inches apart. These two stakes are connected by a crossbar, a strong flat-sided piece of wood to which they are nailed. The main stem of the tree, after protecting it with sacking or other suitable material, is tied securely to the crossbar with thick cocoa-fibre string. The crossbar should be situated as high alongside the main stem as practicable, and it should be fixed on to the south side of each stake.

Dwarf Pyramids and Raspberries.

All tall-growing Raspberries and Dwarf Pyramids on dwarf rootstocks need support. Stout sweet-chestnut stakes of about 3–4 inch diameter and spaced at about 18 feet apart in the rows should be driven in to stand firmly erect, about 4 feet tall for Raspberries, 4–6 feet for Dwarf Pyramids. It is advisable to have rather more substantial posts at the ends of the rows, which will serve to take the strain of taut wire or hop-string and to withstand knocks and brushes by cultivators.

Support for the individual canes of raspberries is provided either by tying them individually to a single wire strand which is strained and fixed to the tops of the stakes, or by two strands of hop-string that envelop the canes on either side of a row and are strained tight to the nearest stakes. The latter form of support tends to hold the canes together in clusters and must be renewed annually, but it has the advantage of dispensing with the necessity of tying the individual canes. When the hop-string support is being fixed during Autumn and Spring, it is wise also to tie together the strands on each side of a row every 3–4 feet.

For Dwarf Pyramids which are destined to occupy the same site for several years, substantial and durable straining posts at the row ends are needed, old railway sleepers being very serviceable. Some favour angular or tubular steel uprights for the intermediate posts, whereas others are content with stout chestnut stakes. Two or three strands of wire of heavy gauge are needed, one strand should be strained to the posts at about 2 feet from soil level and the other at 4–5 feet, a third may be intermediate between these two (see Fig. 5). For the first few years, short bamboo canes should be used as individual tree supports and these should be fixed to the two wires and stand erect. During the early years each tree is tied to one such cane.

Cordons, Loganberries and Blackberries.

Substantial supports about 5–7 feet tall in the form of a wire fence are usually favoured. The fixtures should be similar to

those just described for Dwarf Pyramids, but rather taller. From 4 to 6 stout wire strands are needed and these are strained to the posts at even intervals, the lowest wire strand being about 1 foot from soil level.

The individual new season's canes of loganberries and blackberries are spread out fanwise and tied to the wires. It may be advisable in the case of loganberries to tie the fruiting canes on a half-fan so that the new season's canes can be directed so as not to lie directly under the older ones. If this precaution is taken they will be less likely to infection with Cane Spot Disease (see p. 216). It is not necessary to tie the new canes into position until Autumn or Winter. Spring tying is to be advised for sites exposed to keen north and easterly winds. The new season's canes must, however, be prevented from growing out into the rows where they would be trodden on or damaged by horse or tractor and cultivators, and this is done by pushing them alongside the lowest wire and keeping them there by use of small canes on either side.

With Cordon trees individual bamboo supports are needed for the young leading shoots. Each cane is fixed to the wire strands at an angle of about 45–60 degrees in the first instance and the individual trees are tied to the canes at this angle. Later on, as the trees reach the top wire, the angle will be increased. The canes are needed, as with Dwarf Pyramids, to prevent the abrasion of tender shoots by the wires and also to provide tying points in between the wire strands. As the trees extend in length the canes should be moved away from the base towards the tender leading shoots at the extreme ends.

With all fruits for which fence-like support is needed, care should be taken to avoid having the rows too long without periodical breaks. Such breaks, say the 100 yards interval, are of great convenience from the management point of view because they save much time that would otherwise be spent in walking to points of vantage for such purposes as the weighing of fruit and collecting dead wood. Sufficient width at these breaks in the rows should be allowed for the passage of tractor with trailor or cart.

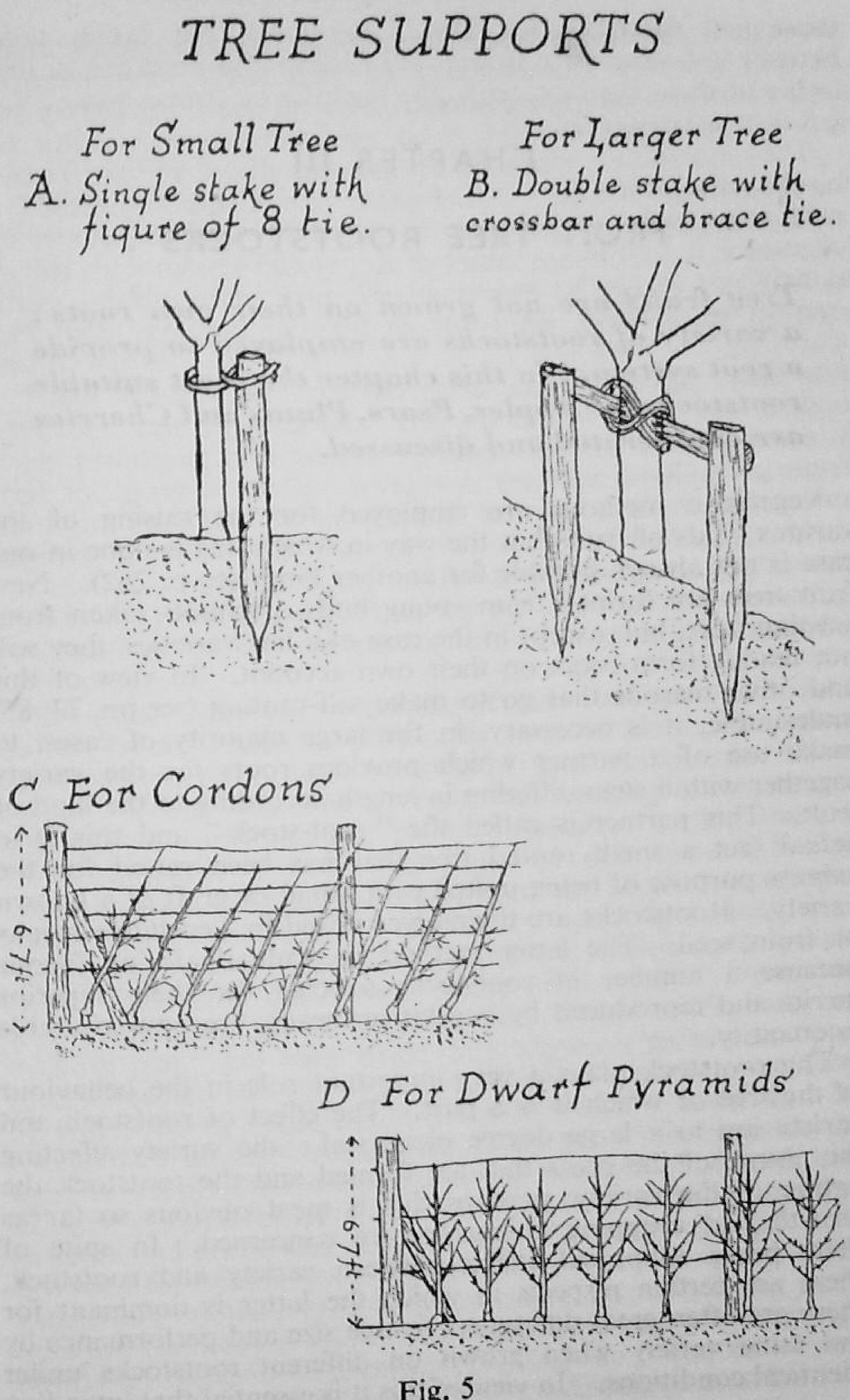
TREE SUPPORTS
For Small Tree
A. Single stake with figure of 8 tie.
For Larger Tree
B. Double stake with crossbar and brace tie.
C For Cordons
6-7 ft
D For Dwarf Pyramids
6-7 ft

Fig. 5

CHAPTER III

FRUIT TREE ROOTSTOCKS

Tree fruits are not grown on their own roots; a variety of rootstocks are employed to provide a root system. In this chapter the most suitable rootstocks for Apples, Pears, Plums and Cherries are enumerated and discussed.

Vegetative methods are employed for the raising of the various kinds of fruits but the way in which this is done in one case is not always suitable for another kind (see p. 262). New fruit trees are formed from young buds or shoots taken from existing trees, but, except in the case of a few varieties, they will not readily form roots on their own account. In view of this and other reasons that go to make self-rooting (see pp. 73, 85) undesirable, it is necessary, in the large majority of cases, to make use of a partner which provides roots for the variety together with a stem differing in length according to the kind of fruit. This partner is called the " root-stock " and this is in actual fact a small rooted tree that has been raised for the express purpose of being united with a bud or graft of a known variety. Rootstocks are themselves raised by vegetative means or from seed. The latter method is gradually losing favour because a number of rootstocks selected for their superior merits and reproduced by vegetative means, are now available in quantity.

The rootstock plays a very important role in the behaviour of the tree of which it is a part. The effect of rootstock and variety are to a large degree reciprocal ; the variety affecting the nature of the roots that are formed and the rootstock the nature of the variety, perhaps this is most obvious so far as growth and cropping characters are concerned. In spite of there being reciprocal effects between variety and rootstock, there are certain respects in which the latter is dominant for there are often great differences in tree size and performance by the same variety when grown on different rootstocks under identical conditions. In view of this it is essential that intending

planters should know what are the best rootstocks for specific requirements. What may be a satisfactory planting distance (see p. 60) for trees on one rootstock may be much too close for another, and what may be a suitable rootstock for one variety may be totally unsuited to another.

There are unfortunately many kinds of rootstocks that cannot be recommended. In order to establish a safeguard against partial or complete failure due to faulty rootstocks, it is essential when ordering trees from a nurseryman to specify the kind of rootstock required as well as the kind and variety of fruit (see p. 48).

There is no single criterion upon which the full value of a rootstock can be assessed. The suitability of various vegetatively propagated rootstocks has been determined after years of trial and observation by workers at the East Malling Research Station. Productivity in relation to tree size, from a given acreage, together with compatibility with the various varieties, are key factors by which the merits have been assessed. It rests with fruit growers to exploit to the full the various commercial potentialities of the rootstocks, which can be recommended with confidence.

The great variations in the size of fruit trees may, to a large degree, be attributed to differences both of kind and variety. The size potential of some varieties is much greater than that of others. Great variations in tree size, notably of apples are also due to rootstock and trees of the same variety may be either comparative dwarfs, or giants or of intermediate size. Some growers may have a preference for large trees planted widely apart, their orchards thus being suited to a high degree of mechanization. When this type of tree is chosen, the grower knows quite well that several years must elapse between the time of planting and crop production, that is unless an intermediate plant has been made with trees on rootstocks more precocious and less vigorous. In course of time large trees can be employed to make effective use of orchard space and the overall size of such trees, when given good management, fits them to supply the maximum bearing surface. The preference of some growers for large trees is due to their intention to apply to grass and graze with sheep (see p. 46). Big trees are often favoured for apples, but not to the same extent for pears which are seldom at their best in grass orchards. When big apple trees are wanted, the choice of rootstocks is generally narrowed down to those conveniently classified as vigorous types; exceptions are varieties like Bramley Seedling and Newton

Wonder which will form large trees on semi-vigorous types (see p. 86).

In contrast with big trees, some growers are attracted to the commercial possibilities of dwarf apple trees. The attractions are their manageable size, that more of them can be planted per acre and that productive crops can be expected within a few years of planting. When Cordons and Dwarf Pyramids are planted, up to 2,000 trees are needed per acre (see p. 52) and the employment of a dwarf rootstock is essential unless the soil is very shallow and the prospect of growth is very slight (see p. 36). Dwarf apple trees may also be planted at close distances as a permanent bush plant, say at 12 feet by 12 feet, for sorts like Cox's Orange Pippin and 21 feet by 21 feet, for sorts like Bramley, nevertheless it is more usual to employ them as an interplant between more vigorous trees (see p. 53).

Between the extremes of the big apple tree and the dwarf are those for which semi-vigorous rootstocks are used. Trees on certain of these semi-vigorous rootstocks are particularly suited for the short-stemmed bush forms since they impart sufficient vigour to grow within a comparatively short space of time, into sizeable trees of a kind from which productive crops can be obtained early in life. At the same time, they have an easily managed compact head. Although some growers plant dwarf trees in between trees on semi-vigorous rootstocks, there is very little to be gained by doing this, provided full use is made of the possibilities afforded by trees on semi-vigorous rootstocks. There is however, on occasions, something to be said for interplanting semi-vigorous types between vigorous types (see p. 61).

In general, preference should be given to vegetatively raised rootstocks rather than to seedling rootstocks. There are several reasons for this, the chief of which is that greater uniformity of response may be expected by virtue of the fact that all vegetatively raised rootstocks of the same type are members of the same clone (i.e. they have all been derived from one parent by vegetative means). The commercial importance of a dependable standard of uniformity in respect both of tree size and crop production is self evident.

In the case of pears, various selected Quinces have proved to be generally the most satisfactory rootstocks. There are, however, some varieties such as Dr. Jules Guyot, Marguerite Marillat and Williams' bon Chrétien that are seldom satisfactory when joined up by grafting or budding direct on to Quince (see pp. 58, 88); this is because a high proportion of the

trees remain small and stunted or exhibit some other evidence of incompatability. The Thorny Pear rootstock (*Pyrus communis*) is more suited for the above-mentioned varieties, but unfortunately selections that have been made have proved difficult to raise vegetatively and, on this account, seedling pear rootstocks are favoured as an alternative. A choice that is rapidly gaining favour is afforded by grafting varieties that do not succeed on Quince onto young trees of a variety that does well on Quince. In this way one has what is known as " double worked " trees ; i.e. trees that are made up of three composite parts, first the Quince rootstock, next, but joined to the Quince, a compatible variety and third, joined to the compatible variety, the sort that is incompatible with Quince. The stem that forms the link between the Quince rootstock and the variety head is referred to as the " intermediate scion." The pear variety Beurre Hardy is regarded as highly suitable for this purpose (see p. 58).

Double working is not generally regarded as necessary for other tree fruits although the writer is of the opinion that advantages could be gained by using it with certain varieties of plums. The variety Early Laxton plum does not readily form a stout stem or good head even when worked directly on to vigorous kinds of rootstock, furthermore this variety is very subject to the disease, Bacterial Canker (see p. 236) which not infrequently causes stem injuries resulting in the death of trees. In some cases the casualty rate from this cause is very high. There is very good reason therefore to provide this variety, and possibly Giant Prune as well, with a sturdy stem of a variety highly resistant to the disease in question, this could be achieved by head-grafting it onto such varieties as Warwickshire Drooper or Blaisdon Red (see p. 91). The same may be said for the varieties Victoria and Czar, which, although capable of forming satisfactory stems, are very subject to Bacterial Canker and Silver Leaf (see p. 234). Since the varieties Warwickshire Drooper and Blaisdon Red are employed as rootstocks, double grafting need not be resorted to, but the trees should be head-grafted rather than low worked (see p. 269). However, it is not a new departure to employ one variety to form the stem of another, that is to form the head ; the method has been employed for many years for certain weak-growing cider varieties which of themselves do not form good stems.

Cherries are invariably head-grafted because the rootstocks employed have greater disease resisting propensities. Seedling cherry rootstocks are, at present, employed to a greater extent

than those vegetatively propagated, although selected, vegetatively-raised rootstocks are now being increasingly used for this fruit.

ROOTSTOCKS FOR APPLES.

Pioneer work has been done by workers at the East Malling Research Station upon the classification of the vegetatively raised apple rootstocks. They are classified on the basis of botanical characters but are best known for the specific characters they impart to a scion variety (i.e. the variety grafted or budded upon them). Type numbers have been given to these rootstocks and four of the types can be recommended with confidence for widespread commercial usage and two for usage to a limited degree. The types recommended for general use are Malling Nos. IX, II, I, and XVI and those for limited use are Malling Nos. VII and XIII.

(i) Malling No. IX Rootstock.

Of the classified types of apple rootstocks, No. IX has the most dwarfing effect upon the scion variety. Hence it is very suitable for systems such as Cordons and Dwarf Pyramids for which a large number of small productive trees are needed per acre (see pp. 46, 82). This rootstock has also been employed to a considerable extent as a temporary interplant between more vigorous permanent trees and to a limited extent as a close bush plant by itself (see p. 82). The attraction of having trees on this rootstock not only lies in the fact that they remain small as long as no scion rooting takes place (see p. 73), but also because they yield crops earlier in life than other more vigorous rootstocks ; this benefit is further enhanced by the fact that more trees can be planted per acre.

There are, however, very definite commercial disadvantages attending the No. IX rootstock. Its root part is very brittle and unless trees on it are effectively supported by stakes, or are planted in a sheltered position, it is easily blown over by strong autumnal winds. Furthermore, some difficulties are experienced in tractor cultivation between the close planted dwarf bush trees of the spreading type that normally result from the employment of this rootstock. In view of these disadvantages and because it is now possible, by adopting suitable pruning methods, to obtain productive crops early in life from trees on semi-vigorous rootstocks, the practice of planting bush trees on No. IX, either as an interplant or a permanent plant, is of doubtful value. Nevertheless, No. IX is undoubtedly the best

rootstock for Cordons and Dwarf Pyramids under soil conditions that would normally give rise to reasonably good growth. This is because adequate supports are normally provided for them and their size is strictly limited by pruning and rootstock effect.

Some varieties make only relatively small, precocious trees when worked on to semi-vigorous and vigorous rootstocks and cannot be regarded as suitable subjects for No. IX rootstocks : such varieties include Lord Lambourne, James Grieve, Millers Seedling and Early Victoria. Other varieties which do not form an altogether satisfactory tree on No. IX are Worcester Pearmain, Grenadier, Lord Derby, Edward VII and Crawley Beauty.

It should be borne in mind that the more dwarfing a rootstock is the greater will be the disposition of the variety to form scion roots. Hence with No. IX rootstock great care should be taken to plant so that the union (i.e. junction between stem of rootstock and variety) is slightly above soil level (see p. 73).

(ii) Malling No. II Rootstock.

This is classified as a semi-vigorous type. It possesses qualities that give it first place for large-scale commercial apple growing as bush trees. There are not many soil types suitable for dessert apples where this rootstock could not be recommended with confidence. No. II rootstock produces trees of reasonable size from which productive crops can be obtained within a few years of planting. Since differences in soil type and management do account for great vigour variations, it is of great advantage to employ a rootstock with a good cropping record under a wide range of conditions. The commercial asset of a rootstock that possesses adequate inherent vigour with a high potentiality for productivity need not be stressed. No. II rootstock can be classed as a good feeder because trees on it do not appear to exhibit pronounced symptoms of mineral deficiency so readily as trees on certain other rootstocks e.g. Nos. V and I.

Possibly the chief disadvantage of No. II rootstock arises when the stem of the rootstock is more than a few inches tall and when trees are planted so that the bud or graft union is several inches above soil level. When this occurs trouble is frequently experienced due to the readiness with which the trees are blown over.

The No. II rootstock is best suited for bush forms of tree. Under growing conditions where one is justified in anticipating

good growth the No. II rootstock is too vigorous for close planting e.g. the Cordon and Dwarf Pyramid plants. A cultural technique designed to restrict vigour is necessary when such a circumstance arises.

It is to be doubted whether satisfaction would be obtained from tall stemmed trees such as Standards and Half-Standards on No. II rootstock, since they tend to form only small heads with slender stems rendering them unsuitable for the ladder work necessary for tall trees. Furthermore, it is to be expected that tall stemmed trees would blow over more readily than is the case when more vigorous types of rootstocks are employed. Nevertheless No. II rootstock is eminently suited for tall stemmed bush trees for varieties such as Bramley's Seedling and Newton Wonder.

(iii) Malling No. I Rootstock.

It would seem hardly necessary to give this rootstock a place in the list of recommended types since varieties worked on to it more closely approximate to those of No. II than does any other type. Without question No. I rootstock provides a better anchorage than No. II and for this reason it possesses some attraction for those planting in rather exposed situations. It is to be doubted whether No. I is as good a feeder as No. II, because it is evident that with many varieties on Type I there is a conspicuous loss of vigour soon after cropping commences. In view of this, rather more generous manurial treatment, especially in respect of Nitrogen, may be required for trees on No. I, once heavy crops are being yielded, than for trees on No. II. No. I rootstock does, however, appear to be ideally suited for the variety Worcester Pearmain since not only are good trees formed with good anchorage, but they possess the additional advantage of yielding fruit of better colour.

(iv) Malling No. XVI Rootstock.

This rootstock is most suited to the production of large trees and is conveniently classified as a very vigorous rootstock. Trees worked on to it do not yield crops so early in life as they do on the less vigorous types already dealt with, and some difficulty is often experienced in converting its vigour into satisfactory bearing surface, especially when branches are erect and are formed near together. No. XVI rootstock should seldom be chosen for bush trees grown under arable conditions but is in all probability the best choice for Half-Standard and Standard trees grown in grass.

(v) Malling No. VII Rootstock.

Although there are difficulties associated with the raising of this rootstock due to the formation of root galls, its chief commendation lies in the fact that it produces precocious trees intermediate in size between Nos. IX and II. For this latter reason it is classed as a semi-dwarfing rootstock. It should be noted that no ill effects have as yet been noted either in experimental or commercial plantations as a result of root galls. Nevertheless trees on it appear to be more subject to the apple Canker disease, when grown on moist soils with high water table, or where the drainage is not ideally suited for dessert apples (see pp. 36, 224).

This rootstock may normally be relied upon to supply adequate initial vigour to form sizeable trees within a few years and at the same time to yield crops early in life. Unlike No. IX rootstock, trees on it do not blow over readily and they have a more erect growing habit. These are qualities that commend it as an interplant between more vigorous types on favourable soil types, in preference to No. IX (see p. 82). Furthermore, No. VII rootstock should be preferred to No. II for Cordons and Dwarf Pyramids under soil conditions where No. IX would not be sufficiently vigorous (see p. 46).

(vi) Malling No. XIII Rootstock.

No. XIII is classified as a vigorous rootstock and as compared with other vigorous types it is relatively a surface rooting one. Although the employment of particular rootstocks cannot compensate for serious deficiencies in soil characteristics such as poor drainage and insufficient depth, yet a judicious selection of rootstock goes a long way to enhance the prospect of success on soils of the borderline category. No. XIII has general value as a rootstock where large-sized trees are wanted and it has the rather specialized value of being suited for the somewhat less well-drained, shallower soils. It is possible to employ No. XIII for such soils as those just mentioned on the field scale or for small areas that are less well suited for the employment of Nos. II and I rootstocks.

ROOTSTOCKS FOR PEARS.

There are very many kinds of Quince but care should be taken not to employ them indiscriminately as rootstocks for pears. There are only three selected kinds of Quince that at present can be recommended for most pear varieties and they are Malling Quince A, Malling Quince B and Malling Quince C.

In view of the very great similarity in performance of trees on Quince A and B it is proposed to deal with them together.

Pear seedlings are not more certain than some of the Quince varieties and the round-leaved thorny pear is most favoured, although its value as a rootstock is limited to a few varieties.

(i) Malling Quince A and B Rootstock.

These rootstocks are ideally suited for bush trees of most pear varieties. The selection Quince A has been employed more than Quince B although the latter frequently produces somewhat larger trees with correspondingly heavier crops. These rootstocks may be regarded in much the same light as Nos. I and II for apples.

(ii) Malling Quince C Rootstock.

Trees on Quince C do not grow to the same size as those on Quince A or B, and it may be regarded as a semi-dwarf similar to No. VII of apples. There are indications that Quince C is a poorer potash feeder than either Quince A or B. Good vigour for most pear varieties is an asset since large fruits are invariably favoured. In view of this it is doubtful whether Quince C can be generally recommended for bush trees. It is undoubtedly the best choice as a rootstock for Cordon pears and as bush trees for strong growing sorts such as Doyenne du Comice. Also it may be used as an interplant between trees on the more vigorous Quince A and B.

The various forms of incompatibility between rootstock and scion variety are occasionally responsible for lack of success with a few varieties of pear on any Quince rootstock. Well-known varieties to which this applies are Dr. Jules Guyot, Williams' Bon Chrétien and Marguerite Marillat. In view of this the practice of double working is recommended (see p. 82) or the employment of Thorny Pear seedlings. There is reason to believe that the varieties Triomphe de Vienne and Bristol Cross would also benefit from double working. Nevertheless Quince may be employed with these sorts for Cordons because of the support given to the individual trees.

(iii) Thorny Pear Seedlings (*Pyrus communis*).

The chief value of these rootstocks is for tall-stemmed trees (i.e. Half-Standards and Standards) and for bush trees for certain varieties referred to above that do not succeed on Quince. Before planting tall-stemmed pear trees, growers would do well to consider the difficulty of their management especially in respect of pruning and harvesting (see p. 182).

TABLE ILLUSTRATING SUITABILITY OF ROOTSTOCKS FOR APPLES.

Dwarf.	Semi-Dwarf.	Semi-Vigorous.	Vigorous.	Very Vigorous.
Malling No. IX. Suitable for Cordons and Dwarf Pyramids and, to a limited extent, for bush trees.	Malling No. VII. Suitable for bush trees as an inter-plant between bush trees on more vigorous types. Also suitable for Cordons and Dwarf Pyramids under conditions where No. IX would not have sufficient vigour. Only suited for conditions of perfect drainage.	Malling Nos. II and I. Suitable for bush trees. No. II as first general choice and No. I for sites exposed to autumn gales and for the variety Worcester Pearmain. May be used for both temporary and permanent trees.	Malling No. XIII. Suitable for Half-Standard and Standard trees. Also suitable for bush trees on soils of borderline suitability as far as depth and drainage are concerned.	Malling No. XVI. Suitable for Half-Standard and Standard trees.

TABLE ILLUSTRATING SUITABILITY OF ROOTSTOCKS FOR PEARS.

Semi-Dwarf. Quince C.	Semi-Vigorous. Quince A and B.	Semi-Vigorous–Vigorous. Quince A or B plus Beurre Hardy Stem.	Very Vigorous. Thorny Pear Seedlings.
Suitable for Cordons and for vigorous varieties, e.g. Doyenne du Comice.	Suitable for bush trees, except for incompatible sorts.	Suitable for sorts incompatible when joined direct on to Quince.	Suitable for sorts incompatible on Quince. Also suitable for Half-Standard and Standard trees.

ROOTSTOCKS FOR PLUMS.

Various species of *Prunus* from which plum varieties have been derived, are widely employed as rootstocks. It has been a common practice to raise seedlings or to take rooted suckers (i.e. young shoots that grow up from the roots of an established tree). Clones of selected seedling types are now available; they are known by various common names and can be raised vegetatively, some by layering and some by cuttings. The most valuable of the vegetatively raised stocks are: Myrobolan B, Brompton, Common Plum and Marianna. In addition to these there are certain plum varieties that are widely employed as rootstocks, viz: Pershore Yellow Egg, Kentish Bush, Blaisdon Red, Warwickshire Drooper and Cambridge Gage.

The issues governing the selection of plum rootstocks are not so clearly defined as for apples and pears. With certain exceptions all the rootstocks named above may be employed for all plum varieties without pronounced differences in tree size.

(i) Myrobolan B Rootstock.

This is one of the most widely used rootstocks for plums and one that produces large productive trees. It is not suitable for the variety Oullin's Golden Gage with which it is incompatible. Myrobolan B rootstock can be readily raised from cuttings taken during Autumn (see p. 263).

(ii) Brompton Rootstock.

A generally good rootstock that produces large trees, and by some authorities is regarded as the best all round rootstock for plums.

(iii) Common Plum Rootstock.

This rootstock has a partial dwarfing effect and produces trees of only medium size in comparison with most. Not only may it have some attraction to growers who do not want a large-sized tree, as might well be the case when an interplant of plums between cherries is wanted, but it has the added advantage of imparting increased resistance to the Silver Leaf disease (see p. 234). At least it can be said that there are less fatal casualties due to Silver Leaf when worked on Common Plum than when worked on some of the well-known vigorous rootstocks such as Myrobolan B. The variety Victoria being very subject to Silver Leaf, some favour the Common Plum rootstock for it. The variety Czar which is also subject to Silver Leaf is unfortunately incompatible with Common Plum and should therefore not be used for it.

(iv) Marianna Rootstock.

Similar to Common Plum, this rootstock should not be used for the variety Czar. For other sorts it is a good rootstock which produces large-sized productive trees. This rootstock can be raised readily from cuttings.

(v) Kentish Bush, Blaisdon Red, Pershore Yellow Egg, Warwick shire Drooper, Cambridge Gage.

These plum varieties have gained some prominence as rootstocks chiefly in the counties in which they originated, viz. Kent and Herefordshire, Worcestershire, Warwickshire and Cambridgeshire respectively. Not only are the varieties Warwickshire Drooper and Blaisdon Red markedly resistant to Silver Leaf and Bacterial Canker (see p. 234), but they form large trees with stout stems. These features commend them as rootstocks for varieties that are susceptible to Bacterial Canker or which do not form satisfactory stems. In such cases, Warwickshire Drooper and Blaisdon Red rootstocks are employed to supply the main stems, as well as roots, and the chosen varieties are head-grafted on to a number of branch shoots formed at the head of the stem. Varieties for which this practice may be considered worth while are Early Laxton, Victoria, Giant Prune (see pp. 83, 236). Whereas Kentish Bush and Cambridge Gage form trees with stout stems the former is rather more subject to Silver Leaf and little is known about the latter as a suitable stem builder.

ROOTSTOCKS FOR CHERRIES.

Less is known about cherry rootstocks than about those for the fruits with which we have already dealt. Wild cherry seedlings and suckers from such seedlings, commonly called "Mazzard" (*Prunus Avium*), are dug up from woodlands and used extensively as cherry rootstocks. Another well-known cherry rootstock is the Mahaleb (*Prunus mahaleb*) of continental origin and sometimes called St. Julie Cherry.

Clones have been established of certain selected Mazzards and from them cherry rootstocks are now being raised by vegetative methods in considerable quantity. The pioneer work has been done at East Malling Research Station and the two selections that can be recommended and are being propagated and employed for commercial plantings are known as Mazzard F 12/1 and Mazzard F 5/4. Of these two rootstocks, Mazzard F 12/1 is the more strongly favoured.

For Morello cherries Mazzard rootstocks are to be preferred to Mahaleb since on Mahaleb the trees are usually short lived.

CHAPTER IV

POLLINATION

Good fruit crops cannot be obtained without effective dissemination of suitable pollen by insects. The pollen provided by some fruits is suitable for the fertilization of their own blossoms; but it is not so with others. The pollination of Soft Fruits and Tree Fruits is dealt with in this chapter and the considerations that should govern the inclusion of pollinator varieties when planting are reviewed.

In planning orchards the present day grower cannot afford to neglect the all important question of pollination, inasmuch as well-directed planning in this respect invariably enhances the prospect of cropping and in some cases makes all the difference between negligible crops and good crops. It is generally admitted that good cropping is primarily dependent upon a good supply of blossom, but it is not generally appreciated that good blossoming is no guarantee of good cropping. Several factors may be contributory causes of crop failure even where there has been good blossom. Crop failures, excepting failures due to frost, are due to four main causes, viz. pests, diseases, faulty nutrition and faulty pollination.

Stated simply, fruiting is but the act of seed production. Fruit growers are not particularly interested in the fact that seeds are borne by the various fruit trees but they are interested in what accompanies the seed, what is commonly referred to as the fruit. Nevertheless it cannot be ignored that the production of one is intimately bound up with the development of the other. Even if the grower is not interested in fruit seeds, he must pay some attention to the mechanism by which they are formed, because the production of good crops is seldom possible without seeds. Before an embryonic seed (ovule) can grow, the act of fertilisation must take place. This implies that the germination tube of a pollen grain has come into contact and fused with an ovule. It follows that it is a very important

practical consideration that suitable pollen is available to effect fertilisation. The first essential is a transference to the stigmas of pollen grains from the anthers, on which they are borne, to facilitate their germination and eventual fusion with ovules. This transference is termed " pollination ", and it is effected, in the case of fruit blossoms, mainly by various pollinating insects and to a limited extent by hand and mechanical means. The blossom of fruit trees is constructed in such a manner that each flower supplies both pollen and one stigma or more. Sometimes the pollen of a particular variety of fruit is suitable to effect the fertilisation of its own flowers and in such cases the variety is termed " self-fertile " and the pollen " self-compatible." Most soft fruit varieties and some tree fruits are self-fertile. Sometimes a pollen is totally unsuitable for fertilising blossoms either on the same tree or on the same variety, and when this is so, the variety is termed " self-sterile " and the pollen " self-incompatible." All sweet cherry varieties and a few apples, pears and plums are self-sterile. In between the two extremes there are varieties of different kinds of fruit where only a comparatively poor or moderate fertilisation of blossoms can result from pollen of their own kind. Such varieties are classed as " partially self-fertile." Although a pollen may be unsuitable for fertilising blossoms of its own kind, it may be very suitable for fertilising other kinds. Suitable combinations of pollen and ovules for the act of fertilisation are conveniently termed " compatibles ", whereas unsuitable combinations are known as " incompatibles."

It is evident that a fruit grower should be in possession of certain basic information concerning the fertility status of the various fruit varieties he is growing. Such information will affect very considerably his distribution of varieties and planting plans (see pp. 98, 105). For instance, if a particular variety of fruit which is self-sterile is favoured, the grower will know that it is necessary to plant in close proximity to it another variety that will provide compatible pollen and effect good fertilisation. When a second variety is chosen for this purpose it is spoken of as the " pollinator " variety. In the event of a pollinator being necessary, the selection should be based upon five main requirements, viz. :—

(i) Compatible pollen, and if possible intercompatibility between the two sorts.

(ii) Suitable overlap of flowering period of pollinator and main variety.

(iii) The choice of marketable sorts as pollinators.

(iv) Assurance that cultural management required by the main variety is suited to that required by the pollinator.

(v) Assurance of regular blossom ; thus markedly biennial sorts are not ideally suited as pollinators (e.g. Laxton's Superb, Ellison's Orange and Miller's Seedling) (see pp. 57, 193).

Fortunately there is usually some latitude of choice of suitable pollinator varieties. The provision of satisfactory pollinator trees in sufficient numbers and at suitable distances is the first important step a grower should take to facilitate the dissemination of suitable pollen. On sites exposed to cold north-easterly winds, growers are advised to provide shelter and so far as is practicable to create suitable conditions for pollinating insects. Furthermore, the practice of introducing colonies of bees into orchards at blossoming time is a well-established practice and commendable, particularly in localities where the wild insect population is not regarded as adequate to deal with large acreages devoted to fruit crops. A preferable alternative to this is the permanent establishment of a few colonies of bees, possibly 1 colony per 5–10 acres, provided they are in charge of someone who knows how to deal with them.

SOFT FRUITS.

With the exception of a few strawberry varieties no system of providing pollinators for the recommended sorts of soft fruits need be adopted and even with strawberries it is only necessary with one of the recommended sorts. The variety Tardive de Leopold is favoured by some growers since it is a late-season cropper. This variety is to all intents and purposes non-staminate and therefore does not yield any pollen. This implies that Tardive de Leopold is entirely self-sterile and no fruits will be borne when it is planted alone (i.e. without a pollinator). The variety Huxley Giant is favoured as a pollinator. Although Royal Sovereign is a better pollinator the plants deteriorate quickly as a result of virus diseases (see p. 219). It is unwise to have more than four rows of Tardive de Leopold to one row of pollinators. A variety by the name of Oberschlersien planted extensively a few years ago came into the category of being only partially self-fertile and in consequence a large percentage of the fruits produced by it when planted alone were small and badly mis-shapen and this resulted in considerably reduced crop yields. Either Royal Sovereign or Huxley Giant are suitable as pollinators for Oberschlersien

and one row of pollinator to six of the main variety will suffice to effect good pollination. The planting of pollinators with strawberries is a mixed blessing since the variety Royal Sovereign seldom thrives when planted in associaton with Tardive de Leopold or Oberschlersien ; this is due to its susceptibility to a virus disease which it invariably contracts from them and which results in its rapid deterioration.

Like certain other of the soft fruits, a particular variety of strawberry, introduced and planted widely in its day, may have a short-lived commercial usefulness because of its deterioration or because it is superseded by one of superior merit. Thus the recommendations made in respect of Tardive de Leopold and Oberschlersien may appear to be irrelevant in a few years time. Nevertheless whatever varieties do exhibit commercial promise, intending planters should first ascertain whether or not they are self-fertile. There are indications that the recently introduced variety Climax would benefit by a pollinator.

TREE FRUITS.

Apples.

This fruit has been conveniently classified into two types, one called " triploids " and the other " diploids." There is a fundamental difference in the living contents of the cells of these two types, triploid varieties having received two sets of chromosomes from one parent and one from the other, whereas the diploid varieties have only received one contribution from each parent. Pollen produced by triploid varieties with their odd number of chromosomes is poor for pollination purposes but the pollen yielded by diploid varieties with their even number of chromosomes is good. From this it should not be inferred that the pollen of all diploid varieties is self-compatible, for this is not the case, but it may be inferred that they are good pollinators. Only two of the varieties recommended for commercial planting, viz. Bramley's Seedling and Ribston Pippin (see p. 57) are triploids and should therefore be avoided for use as pollinators. Pollinators for triploid varieties should show a high degree of self-fertility or otherwise a further variety will be required to pollinate the pollinator.

Certain of the recommended diploid varieties may be considered self-fertile, since not only are they very free croppers but several of them tend to yield excessive crops even when only moderate blossom is borne, a characteristic which contributes to the unwelcome biennial cropping habit (see pp. 94, 193). In view of this, the writer would not provide

pollinators for the varieties Early Victoria, Grenadier, Miller's Seedling, Laxton's Superb and Crawley Beauty. Of the varieties that remain, the following recommendations are made :—

TRIPLOID VARIETIES.

BRAMLEY'S SEEDLING.

Pollinators : **Worcester Pearmain or Grenadier.**

Worcester may be favoured when grass orcharding is intended and when soil drainage is reasonably good. Grenadier is best suited for arable conditions.

RIBSTON PIPPIN.

Pollinator : **Lord Lambourne.**

Care should be taken to ensure that the Lord Lambourne trees are free from the "chat fruit" and "rubber wood" troubles. This applies also to future references to this variety.

DIPLOID VARIETIES.

COX'S ORANGE PIPPIN.

Pollinators : **James Grieve, Worcester Pearmain, Tydeman's Early Worcester, Sunset, Laxton's Fortune.**

Perhaps the best single pollinator for Cox is James Grieve, but to plant it as the only pollinator would involve too great an acreage of an apple with a short season and of limited market possibilities. The variety Worcester is a good pollinator and a good market sort, although somewhat later in flowering than Cox. There is much to be said for the inclusion of both pollinators where large plantings are concerned to cover the Cox flowering season and to enhance the prospect of good pollination with the minimum inconvenience from a sort which has a limited market value. Although little is known about the market qualities of Sunset, one of its attractions as a pollinator is that the harvesting season coincides with that of Cox's Orange Pippin. James Grieve should not be chosen in localities of high rainfall because of its susceptibility to the apple canker disease (see p. 224).

TYDEMAN'S EARLY WORCESTER and WORCESTER PEARMAIN.

Pollinators : **Lord Lambourne, Cox's Orange Pippin, Tydeman's Early Worcester, Worcester Pearmain.**

Worcester may be regarded as fairly self-fertile, and pollinators of the same frequency as for some varieties is

not necessary. Cox is a good pollinator although as a variety it requires rather a higher nitrogen level than Worcester. Lord Lambourne is rather on the early-flowering side but there is sufficient overlap for a variety of the readily fertile nature of Worcester. Tydeman's Early Worcester may be used as the pollinator for Worcester and vice-versa. For future plantings these may prove to be the best combination.

JAMES GRIEVE.

Pollinators : **Cox's Orange Pippin, Worcester Pearmain.**

James Grieve would seldom be chosen for planting as the main variety. The habit of tree follows more after Worcester than Cox which is of advantage from the cultural standpoint. Another important management consideration is that the picking season of James Grieve and Worcester coincide. As with Worcester, James Grieve is to all intents and purposes self-fertile.

LORD LAMBOURNE.

Pollinators : **Worcester Pearmain, Cox's Orange Pippin, Sunset.**

Lord Lambourne shows a high degree of self-fertility. The advantage of Worcester although rather late flowering is in similarity of habit of tree. The harvesting in this case would come before Lord Lambourne. Cultural conditions required by Lord Lambourne are more closely allied to those for Sunset and Cox's Orange Pippin than to those Worcester needs. With Sunset and Cox, the harvesting follows immediately upon that of Lord Lambourne.

LAXTON'S FORTUNE.

Pollinators : **Cox's Orange Pippin, Sunset.**

Little is known about the requirements of Laxton's Fortune, nevertheless the big range in size of fruit from comparatively young trees would suggest that mature trees will need a moderately high nitrogen level and this is also the case with the varieties recommended as pollinators.

SUNSET.

Pollinators : **Worcester Pearmain, James Grieve, Cox's Orange Pippin.**

Little is known about the pollination requirements of this variety, although there is reason to believe that varieties satisfactory for Cox's Orange Pippin are suitable, although in all probability Sunset is more fertile than Cox.

LORD DERBY.

Pollinator : **Grenadier.**

Both varieties need similar cultural management and both are harvested over a similar period.

KING EDWARD VII.

Pollinators : **Crawley Beauty, Royal Jubilee.**

Crawley Beauty blossoms a little after King Edward VII and cannot be counted upon to blossom during years following a heavy crop. Nevertheless it is probably the best choice, since there are few acceptable sorts and the alternative pollinator referred to, Royal Jubilee, is not a good market variety.

The method of intermixing the pollinator is governed by two main considerations, viz. (i) Effective Pollination and (ii) Ease of general management, especially of harvesting. For growers who require effective pollination by supplying the minimum number of pollinator trees, there is no better system than the so-called 1 in 9 (see Diagram, p. 99). For this system one-ninth of the total number of trees are pollinators and the term 1 in 9 implies that one pollinator is planted to serve eight surrounding trees. The main feature of this system is that every tree of the main variety has a pollinator tree as a near neighbour. The main disadvantage of this system is that management inconveniences in dealing with the pollinator are inevitable. A pollinator demands consideration from the standpoint of nutritional, spraying, harvesting and pruning requirements and its dispersal as isolated individual trees over an entire plant does not allow for this. The alternative choice to the 1 in 9 system is the Single or Double Row system (see Diagram, p. 101). The adoption of this system has undoubted advantages from the standpoint of management considerations, and should therefore appeal to those contemplating extensive planting. A double row system, where two complete rows of pollinators are planted to serve as many as 4–8 rows of the main variety, inevitably necessitates the employment of a greater number of pollinators, thus providing a greater weight of pollen, but all trees will not be in the equal proximity to the pollinator which is afforded by the 1 in 9 system.

The arrangement of pollinators for Cordons and Dwarf Pyramids should be either as single rows, say one row of pollinator to four rows of main variety, or as individual trees down each row, say one pollinator followed by eight of the main

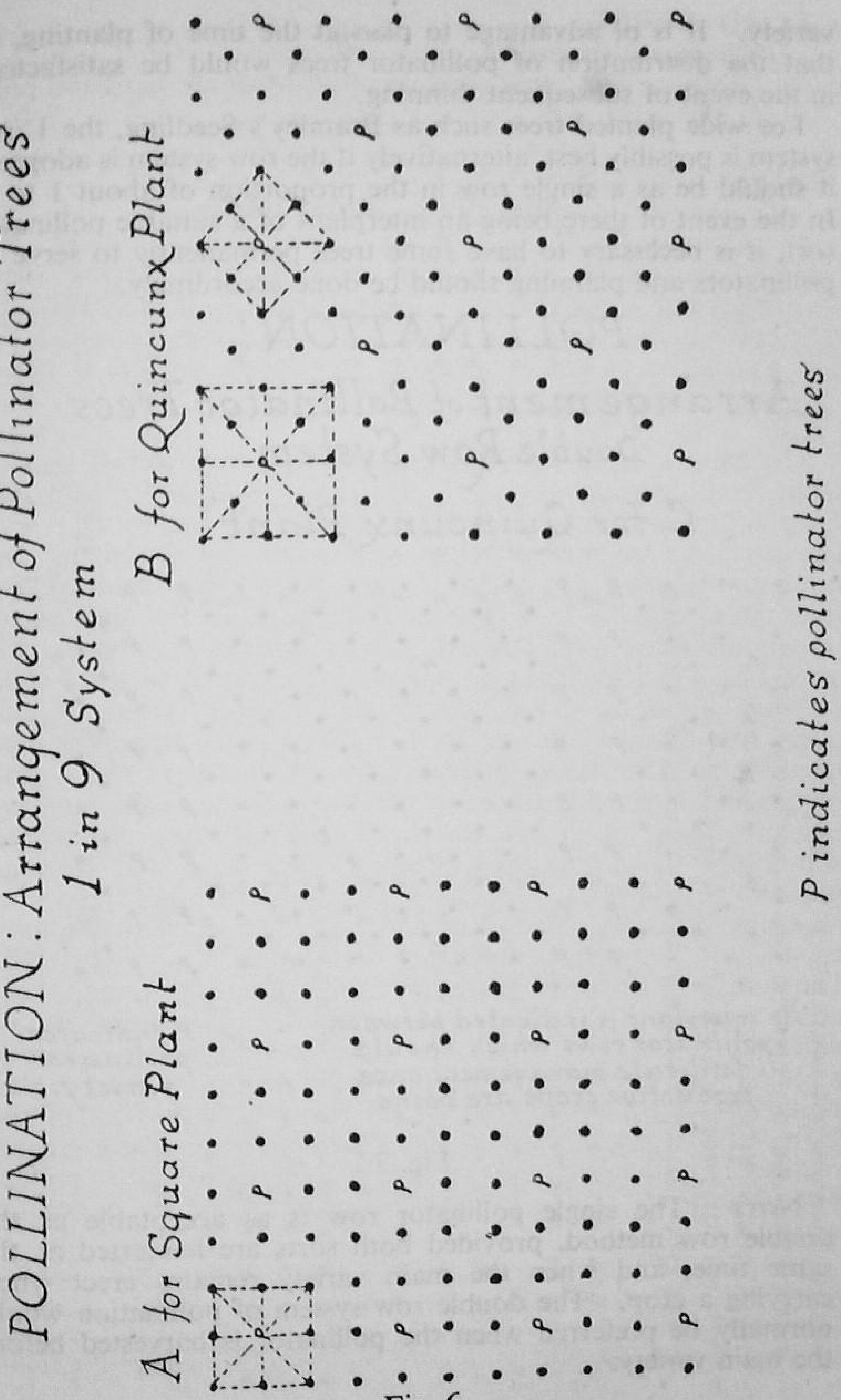
POLLINATION: Arrangement of Pollinator Trees
1 in 9 System
A for Square Plant
B for Quincunx Plant
P indicates pollinator trees

Fig. 6

variety. It is of advantage to plan at the time of planting, so that the distribution of pollinator trees would be satisfactory in the event of subsequent thinning.

For wide planted trees such as Bramley's Seedling, the 1 in 9 system is possibly best, alternatively if the row system is adopted, it should be as a single row in the proportion of about 1 to 4. In the event of there being an interplant of a suitable pollinator sort, it is necessary to have some trees permanently to serve as pollinators and planning should be done accordingly.

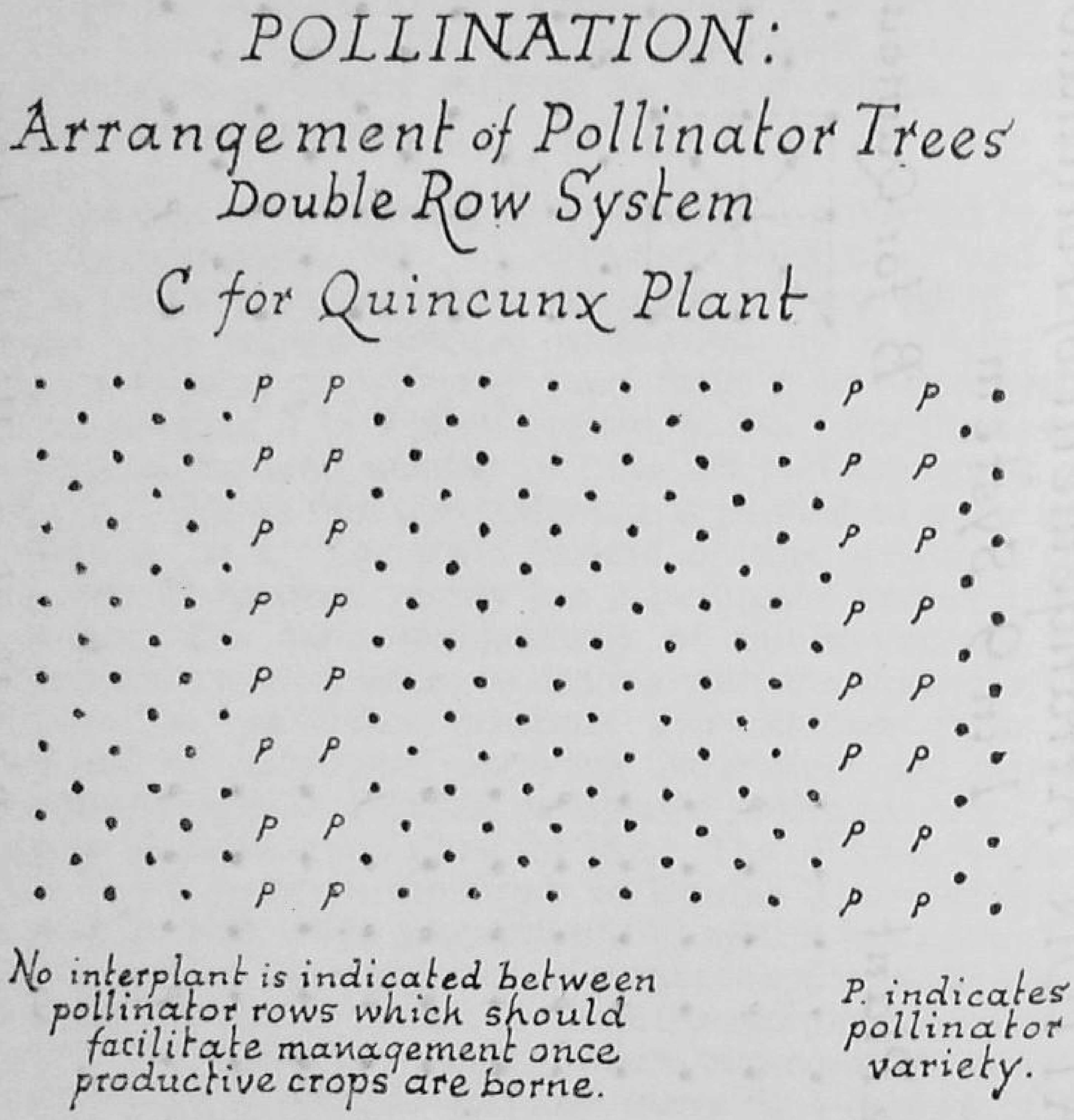

Fig. 7

Note: The single pollinator row is as acceptable as the double row method, provided both sorts are harvested at the same time, and when the main variety remains erect when carrying a crop. The double row system of pollination would normally be preferred when the pollinator is harvested before the main variety.

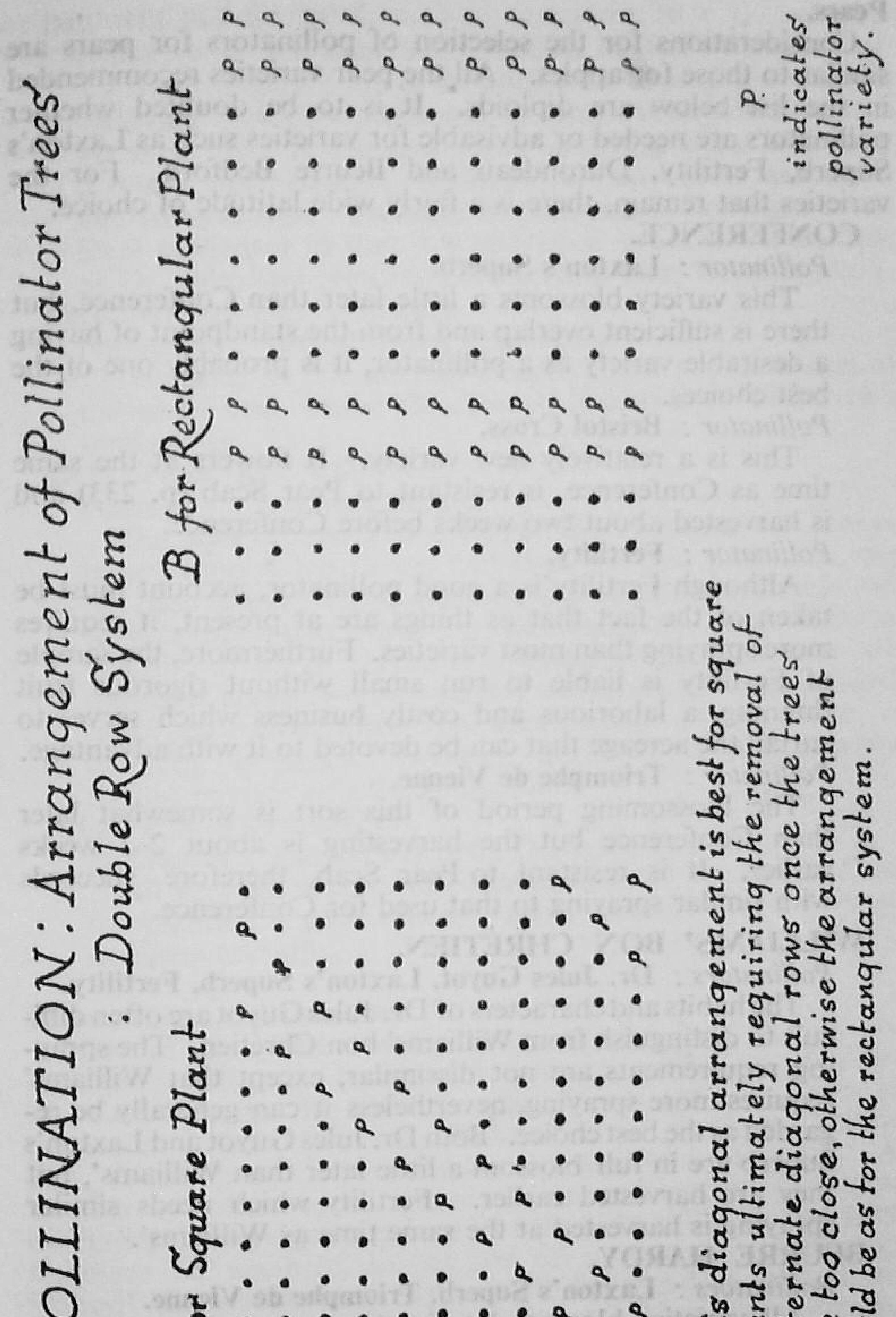
POLLINATION: Arrangement of Pollinator Trees'
Double Row System
A for Square Plant
B for Rectangular Plant
P. indicates pollinator variety.
This diagonal arrangement is best for square plants ultimately requiring the removal of alternate diagonal rows once the trees are too close, otherwise the arrangement could be as for the rectangular system.

Fig. 7

Pears.

Considerations for the selection of pollinators for pears are similar to those for apples. All the pear varieties recommended in the list below are diploids. It is to be doubted whether pollinators are needed or advisable for varieties such as Laxton's Superb, Fertility, Durondeau and Beurre Bedford. For the varieties that remain, there is a fairly wide latitude of choice.

CONFERENCE.

Pollinator : **Laxton's Superb.**

This variety blossoms a little later than Conference, but there is sufficient overlap and from the standpoint of having a desirable variety as a pollinator, it is probably one of the best choices.

Pollinator : **Bristol Cross.**

This is a relatively new variety. It flowers at the same time as Conference, is resistant to Pear Scab (p. 233) and is harvested about two weeks before Conference.

Pollinator : **Fertility.**

Although Fertility is a good pollinator, account must be taken of the fact that as things are at present, it requires more spraying than most varieties. Furthermore, the sample of Fertility is liable to run small without rigorous fruit thinning, a laborious and costly business which serves to curtail the acreage that can be devoted to it with advantage.

Pollinator : **Triomphe de Vienne.**

The blossoming period of this sort is somewhat later than Conference but the harvesting is about 2–3 weeks earlier. It is resistant to Pear Scab, therefore succeeds with similar spraying to that used for Conference.

WILLIAMS' BON CHRÉTIEN.

Pollinators : **Dr. Jules Guyot, Laxton's Superb, Fertility.**

The habits and characters of Dr. Jules Guyot are often difficult to distinguish from Williams' bon Chrétien. The spraying requirements are not dissimilar, except that Williams' requires more spraying, nevertheless it can generally be regarded as the best choice. Both Dr. Jules Guyot and Laxton's Superb are in full blossom a little later than Williams', but they are harvested earlier. Fertility which needs similar spraying is harvested at the same time as Williams'.

BEURRE HARDY.

Pollinators : **Laxton's Superb, Triomphe de Vienne.**

All varieties blossom late in the season. Triomphe de Vienne is harvested directly before Beurre Hardy and both are resistant to Pear Scab.

DR. JULES GUYOT.

Pollinators : **Williams' bon Chrétien, Laxton's Superb.**

From the standpoint of securing trees of similar character, Williams' would be favoured, although it should be borne in mind that it requires more spraying than Dr. Jules Guyot. Furthermore, Williams' is harvested later than Dr. Jules Guyot. Laxton's Superb can be regarded as an ideal pollinator in that it is harvested about the same time as Dr. Jules and requires less spraying than Williams'.

TRIOMPHE DE VIENNE.

Pollinators : **Bristol Cross, Conference.**

Triomphe de Vienne and Bristol Cross are harvested at the same time whilst Conference is harvested about two weeks later.

DOYENNE DU COMICE.

Pollinator : **Laxton's Superb.**

The poor cropping of a variety like Doyenne du Comice is not simply due to the fact that the best pollinator has not been found The disposition to crop or not is determined to a considerable extent by the conditions of the tree as determined by its chemistry. Better crops of Comice are normally borne by twice grafted trees than by single grafted trees, especially when the intermediate parent exerts a dwarfing influence. Growers attracted to this variety should provide effective pollination.

CLAPP'S FAVOURITE.

Pollinators : **Laxton's Superb, Dr. Jules Guyot.**

All varieties need similar management. The justification for planting a poor quality variety such as Clapp's, is its earliness and size.

Plums, Gages and Damsons.

Most of the plum varieties recommended (pp. 58, 93) are self-fertile and may be planted without pollinator varieties. The following are the sorts to which this statement applies in particular : Czar, Victoria, Blaisdon Red, Pershore Yellow Egg, Giant Prune, Warwickshire Drooper and Monarch. A number of other sorts, including the recommended Gages, excepting Cambridge Gage, are classified as self-fertile and may therefore be regarded as capable of producing a full crop without the assistance of pollinators, the varieties referred to are : Belle de Louvain, Early Transparent, Denniston's Superb, Oullin's Golden Gage and Laxton's Gage. Although the truth of this is not doubted, the provision of pollinator varieties for

them all is well justified. Varieties such as Early Laxton, Cambridge Gage, Shropshire Damson and Farleigh Damson require pollinators since they are only partially self-fertile and cropping is likely to be poor when dependence is placed upon their own pollen. The variety Pond's Seedling is the only one of the recommended sorts that is self-sterile and the provision of a pollinator variety must be regarded as essential.

There are several high-quality Gages that many would like to see included in a list for commercial planting, but low average crop-yields accounts for their omission, and when judged on the basis of today's requirements they must be regarded as uneconomic. Fruit growers would do well not to commit themselves too heavily with shy cropping sorts (however attractive they are in some respects) on the assumption that they will succeed in supplying effective pollination and other conditions requisite to secure good cropping, where others have failed. The Gage plums recommended are varieties that have proved their worth during the course of observations made over several years.

For plums and gages the row or block system (i.e. several rows of all varieties) of pollinators is to be preferred to an individual tree system (see p. 98).

POND'S SEEDLING.

Pollinators : **Giant Prune, Majorie's Seedling, Pershore Yellow Egg.**

SHROPSHIRE PRUNE DAMSON.
FARLEIGH DAMSON.

Pollinator : **Czar.**

It should be borne in mind that damsons are often employed as wind-breaks surrounding a plum plantation, in which case the provision of pollinators is not necessary.

EARLY LAXTON.

Pollinators : **Warwickshire Drooper, Victoria, Giant Prune.**

The flowering period of Warwickshire Drooper more nearly approximates to that of Early Laxton, but the harvesting season is much later. This fault also applies to Giant Prune which flowers rather late for Early Laxton. The harvesting season of Victoria is not so late as the other two sorts but casualties are liable to occur as a result of the fungous disease Silver Leaf (see p. 234).

BELLE DE LOUVAIN.

Pollinator : **Czar.**

Belle de Louvain forms a large growing tree whereas Czar forms a relatively small one, it is preferable therefore to have the pollinators as an alternate interplant.

MARJORIE'S SEEDLING.
Pollinators: **Giant Prune, Czar, Victoria, Belle de Louvain.**

CAMBRIDGE GAGE.
Pollinators : **Pershore Yellow Egg, Kentish Bush, Czar.**

LAXTON'S GAGE.
Pollinators : **Oullin's Gage, Czar, Marjorie's Seedling.**

OULLIN'S GOLDEN GAGE.
Pollinators : **Laxton's Gage, Czar, Marjorie's Seedling.**

Czar yields a smaller tree than the Gages and less spreading. Two rows of such a variety can provide a useful wide alley for carrying off the fruit when harvested.

DENNISTON'S SUPERB.
Pollinators : **Early Transparent, Warwickshire Drooper.**

EARLY TRANSPARENT.
Pollinators : **Denniston's Superb, Warwickshire Drooper.**

It is not intended to suggest that the above recommendations offer the only satisfactory choice, when mixing varieties, to provide for good pollination on the one hand, and ease of orchard management on the other. It should be borne in mind that the mature tree of the different sorts varies considerably in size. It behoves one therefore, so far as is possible, either to secure a mixture of varieties that require similar planting distances, or in certain cases to alternate large and small growing sorts, in order to effect an economical employment of orchard space (see p. 62). It is however legitimate and in some cases, where spreading sorts are planted, advisable, as it is with other tree fruits (p. 100), to cater for harvesting. This can be done either by having periodical wide rows or occasional alleyways formed by two rows of an erect growing sort which does not form larger trees than the main variety.

Cherries.

All sweet cherries are self-sterile and it is essential that varieties are so planted that cross pollination is possible between compatible combinations. Comparatively few varieties supply pollen that is compatible with all other varieties, in fact there are eleven known groups, and the pollen supplied by any variety in one group is unsuitable for pollinating other members of the same group. The varieties of the recommended sorts which

should not be planted as near neighbours are, Early Rivers, Knight's Early Black, Roundel; Emperor Francis and Napoleon; Early Amber and Governor Wood. In addition, to be assured of varietal compatibility, there are two other important considerations that should affect the decision as to what should neighbour what, and they are: sufficient overlap in (i) the flowering period and in (ii) the harvesting period, by bringing within proximity sorts that require harvesting in near succession.

It is not essential nor necessarily desirable, that all the recommended sorts should be planted in equal proportion. It is preferable to have the majority comprising only four or five sorts, with only a small proportion of the trees comprising other sorts to provide adequate pollination and continuity of harvesting.

Susceptibility to the Bacterial Canker disease (pp. 60, 239) is a factor likely increasingly to effect the choice of varieties. Napoleon, Emperor Francis, Florence, Amber and Bradbourne Black are varieties very subject to this disease. Napoleon is undoubtedly one of the best varieties for appearance and market purposes and is needed as a key variety. It is nevertheless essential that only healthy trees should be planted.

The following varieties would do well to predominate, comprising about two-thirds of a planting: Early Rivers, Roundel, Amber, Napoleon and Gaucher. Working upon this basis the following arrangement of rows would be suitable:—

Early Rivers. Early Amber or Nutberry Black. Early Rivers. Noir de Guben. Knight's Early Black. Nutberry Black. Early Rivers. Noir de Guben. Early Rivers. Governor Wood. Roundel. Amber. Roundel. Amber. Roundel. Napoleon. Amber. Gaucher. American Black Republic. Napoleon. Gaucher. Emperor Francis. Ohio Beauty (not a recommended variety due to poor quality, but invariably makes a good market price on account of lateness). Bradbourne Black. Florence. Bradbourne Black.

It is not intended to suggest that such an arrangement could be adopted for every site irrespective of size. It is obvious that suitable modification must be made to suit differing circumstances. For a large scale planting, complete rows of the varieties as suggested above could be planted. For smaller scale plantings a reduced number of varieties may be advisable and interplanting the main varieties with suitable pollinators would be necessary. The following would be a suitable arrangement:—

Early Rivers. Noir de Guben. Early Rivers. Governor

Wood. Roundel. Amber. Roundel. Amber. Napoleon. Gaucher. Bradbourne Black.

For small scale planting the pollination may be interspersed in the rows of the principal varieties. This is not practicable where large acreages are concerned on account of the difficulty entailed when harvesting. The following would be a suitable arrangement for small scale planting:—

Row 1. Early Rivers, Noir de Guben, Early Rivers, Noir de Guben, Early Rivers, etc.

,, 2. Governor Wood, Early Rivers, Governor Wood, Early Rivers, Governor Wood, etc.

,, 3. Amber, Napoleon, Amber, Napoleon, Amber, etc.

,, 4. Roundel, Roundel, Roundel, Roundel, Roundel, etc.

,, 5. Bradbourne Black, Gaucher, Bradbourne Black, Gaucher, Bradbourne Black, etc.

CHAPTER V

SOIL CULTIVATION

Various fruits and different varieties of the same fruit, often have differing requirements so far as the cultivation of the soil is concerned. The tillage-needs of the various fruits are outlined and considerations affecting the choice between arable and grass management are dealt with.

For most of the year soft fruits require soil conditions in which the land is kept free of weeds ; and to ensure this, a state of " clean " cultivation must be maintained. Whereas a small amount of annual weed would not mitigate against the successful planting of soft fruits, it is at least essential that perennial weeds should be eliminated before the planting. Nevertheless in the case of strawberries, as clean a state should be secured as is necessary for most arable farm crops.

The establishment of some annual weed in the late Summer and Autumn is not prejudicial to the satisfactory development of bush and cane fruits, so long as no serious difficulty is encountered in bringing the soil back to the clean cultivated state again. In fact, annual weed that subscribes to this requirement is beneficial, inasmuch as it reduces the continuous depletion of soil organic matter that takes place under the clean cultivated state.

For all tree fruits clean cultivation is preferable whilst they are young and so long as vigorous growth is needed. Nevertheless the same degree of " cleanness " is not required as for soft fruits. Late Summer weeds may be allowed to form a considerable bulk of herbage ready for rotting down after Winter ploughing or disc harrowing. Pears and plums are best suited to this form of management both when young and when fully grown ; at least it can be said that they are seldom at their best when grown in permanent grass.

Once apple trees are a few years old, no general ruling as to the best form of management can be given because equally

successful forms of management range from grass orcharding to practically the clean cultivated state. From this it should not be inferred that it is immaterial as to whether apples are grown in cultivated soil or in grass. Such factors as variety, vigour, quality and soil type govern whether it is better to apply apples to one form of management or another.

Although it cannot be stated with certainty that it is invariably best to apply cherries to grass management after the young trees have become well established, there is much to indicate that the general practise is based on sound experience and reason.

STRAWBERRIES.

The close distance from plant to plant and the necessity of preventing the establishment of all weeds, renders considerable hand cultivation necessary in the plant rows. This almost exclusively takes the form of hand hoeing during the early Spring and Autumn months. Hoeings, no deeper than will permit of a thorough destruction of weeds, are necessary. The desirable frequency with which this, and all soil cultivations on strawberries are carried out necessarily depends upon the recurrence of weeds. This is different in different seasons, due mainly to climatic conditions. Some handwork, such as forking or lifting, may be necessary to exterminate perennial weeds such as Couch grass or Docks. Between-row cultivation is normally done with the aid of a horse, or with a tractor which may be a small-powered unit or of a row-track type. The selection of suitable traction is governed by the scale of the undertaking and other farm commitments. For preference, one should choose to be rather over-powered than under-powered. Tine cultivators are chiefly employed for spring work ; the final autumn cultivation should take the form of ridging soil towards the plant rows, leaving a shallow furrow midway between the rows. For this purpose a ridging plough may be employed. The furrow left between the rows serves to take surface drainage water away from the plants during the wettest time of the year and the soil thrown towards the plants aids autumn rooting by compensating for soil drawn away in the normal process of hoeing.

RASPBERRIES, BLACKBERRIES AND LOGANBERRIES.

Rather less detailed hand-cultivation is required by these crops than for strawberries because it is not so imperative to deal with weed-seedlings as frequently, and rather more under

growth of annual weeds is permissible during Autumn. Nevertheless it is imperative to eliminate perennial weed and to perform at least one hand-hoeing operation down the rows during Spring. In the case of blackberries and loganberries, it is usually necessary to hand-dig narrow strips down each row during Winter. This is referred to as " strip " digging. It will be appreciated that hand cultivations of this description are unavoidable when there are posts and when each row is furnished with wire as well as the stools of the growing crop, rendering it impossible to deal with narrow strips by using the routine machine-drawn cultivators.

Autumn ploughing between the rows is advisable ; in it the furrows should be turned towards the rows, leaving an open furrow midway between the rows. Spring and early Summer cultivation is designed to keep down the weeds and conserve soil moisture and should take the form of disc-harrowing or tine-cultivation.

BLACKCURRANTS, GOOSEBERRIES AND RED-CURRANTS.

As with raspberries, Autumn or Winter ploughing is done by turning the soil towards the bushes leaving an open furrow in between the rows. For spreading sorts of blackcurrants, a crop that is grown on the " stool " principle (see p. 72), most growers find it helpful to pull each bush more erect and compact by tying it round with a piece of string prior to the ploughing operation. Such a procedure facilitates closer cultivation to the bushes, thus reducing the amount of hand cultivation. Strip digging is invariably necessary when bushes are planted too close in the rows to allow for cross cultivation by horse- or tractor-drawn implements. On this account, large-scale growers of this crop may prefer a square plant (see pp. 51, 53.) Similar Autumn or Winter cultivation is required by all three crops. Spring cultivations are done with the aid of disc or tine cultivators and in the case of gooseberries which are normally planted on the square system, cross row cultivation is practicable. The first Spring cultivation of blackcurrants should be completed before the tie, referred to above, is released. The close plant system which is normally adopted for blackcurrants and redcurrants does not allow for cross cultivations for more than two or three years. Fortunately, once blackcurrants are fully established little hand cultivation is normally required, since weed does not readily grow under the dense leaf cover afforded by this fruit. Established gooseberries normally require

considerable hand labour in the forms of Spring hoeing and Autumn or Winter digging, since with the increasing size of each bush there is a corresponding increase in the soil area that cannot be dealt with by mechanical means.

Redcurrants do not assume such a spreading habit as gooseberries and in consequence less hand labour is needed by them, although hand hoeing round the base of each bush and strip digging is usually necessary.

Similar tillage requirements are needed by these fruits when they are employed as an intercrop between tree fruits, although as would be expected, with the increasing size of the tree fruits, more hand labour is required than when they are the only crop.

PEARS, PLUMS, GAGES AND DAMSONS.

Very little hand labour is needed for these fruits when they are grown on their own, that is without an intercrop. The form of cultivations is determined by an intercrop, so long as one is grown.

Clean cultivation is required by these fruits during the Spring and early Summer months and this is best done by tractor-drawn disc-harrows or cultivators. Planting distances are normally chosen that allows for down-row and cross-row cultivation. It is impracticable to cultivate right close up to the stem of trees when tractor- or horse-drawn implements are used and consequently a small square in the immediate vicinity of each tree is left uncultivated unless dealt with by hand. For young trees, these uncultivated patches are best dealt with by hoeing during the Spring. Once trees are a few years old and have become established, no hand cultivation is needed to deal with annual weeds ; in fact, very little grows under any trees that provide good leaf cover. It is desirable that perennial weed, such as Couch grass, around trees should be dealt with by hand. Perennial weeds of this description can check seriously the vigour of trees, even when a patch of Couch only occupies a small square. Couch grass frequently does much to aggravate drought effects and since it is desirable to maintain a reasonable state of vigour in pears and plums, steps should be taken to eliminate weed that seriously competes for soil moisture with the growing crop.

The primary purpose of Spring cultivation is to conserve soil water for the benefit of the trees, this is done by eliminating weeds and by maintaining a surface soil mulch. This condition is required so long as an extension of new season's growth is needed. Once sufficient young growth has been made and

fruitlets are rather more than half-grown, the reason for maintaining a clean cultivated state no longer exists. It is advantageous to permit the establishment of annual weed during late Summer and Autumn. This weed should be cultivated into the soil during the following Winter or Spring. An increasing number now favour sowing a cover crop for this purpose (see p. 116).

Many growers do not find it necessary to perform a routine Winter ploughing for these crops. Winter ploughing is beneficial where the soil type is heavy, since under such conditions it helps to ease the subsequent Spring cultivations, furthermore, Winter ploughing is beneficial for surface soil drainage on less well-drained soils, where an open furrow can be left between the tree rows. In any case, where Winter ploughing is deemed advisable, growers prefer either to do it after the Winter spraying or several weeks before, in any case, it should be done before February. It should be borne in mind that movement over freshly ploughed soil with spray hoses is very laborious work.

CHERRIES.

This fruit is often grown with a plum intercrop for the first several years (see p. 63). During the early years, clean cultivation as outlined for plums is advisable. From the time that cherry trees have become firmly established and have reached a size when useful crops may be expected, that is when they have attained an age of from eight to twelve years old, deep cultivations should be avoided because much damage may be done to roots, to the detriment of the trees. This especially applies to cherry trees and it is one of the reasons why most growers of this crop favour changing over from arable to grass conditions at about this stage.

A grass seeds mixture which may consist of 20–30 lbs. Perennial Rye Grass plus 1–3 lbs. Wild White Clover per acre, is sown during Spring or Autumn into previously prepared soil where a reasonably flat surface and a good clean (i.e. free of perennial weeds) tilth has been gained. Generous discing with disc harrows, or tine cultivation should succeed in providing the necessary seed-bed conditions. A tine harrowing immediate upon seeding down is needed to bring a cover of soil over the seed and ring rolling should follow soon after.

Soil under conditions of grass management loses moisture during the Spring and Summer months sooner than a comparable soil under arable conditions. This tendency must not be aggravated beyond the safety limit or otherwise drought

symptoms will become apparent. The best means of guarding against such an effect is to keep the grass short, (usually referred to as " tight ") from the beginning of April to the end of June. Close mowing or grazing is needed during the Spring months once a grass sward is established, in order to safeguard against a considerable check in growth. Furthermore, once trees are productive, fruit size will suffer if grass is allowed to get long during the Spring or early Summer months.

For many years sheep have been the grower's standby to keep grass orchards tightly grazed. Of recent years the tractor-drawn gang-mower has come into prominence. The gang-mower has advantages for growers who do not wish to keep sheep and for types of grass grown under shaded conditions that normally fail to attract sheep. In view of the facts, both that sheep do not graze cherry orchards satisfactorily once the grass is shaded by a heavy leaf cover, and that there are seasons when grass grows too rapidly for the sheep, it is advisable to have some form of mower, either gang or mowing machine as an auxiliary to sheep, so that it is possible to deal with the situation independently if necessary.

Arable conditions involve frequent disturbances of the surface few inches of soil together with a gradual depletion of organic matter, unless this is made good by manurial applications. The reverse is true of pasture, since negligible soil disturbances occurs, and increases in soil organic matter result. Furthermore, under arable conditions the land dries out less quickly during the Summer months than it does under grass conditions. Cherries are normally harvested during the months of June and July and while, on the one hand, young trees are required to form good growth during the entire growing season since crop production is not the immediate consideration, on the other hand, a relatively early cessation of growth is needed with cropping trees, where crop, rather than increases in tree size is the fundamental consideration. Vigorous growth until late in the season is detrimental for trees that should be giving good crops, since reduced crops and increased susceptibility to diseases such as Brown Rot and Bacterial Canker are probable (see p. 239). With young cherries, and with old ones that are declining in vigour, good growth is more likely to be secured by arable than by grass orcharding, and this benefit can invariably be obtained in the case of old orchards by disc-harrowing over the pasture until the turf is killed. Such benefits are likely to be only of temporary duration and should be coupled with suitable manuring after a few years (see p. 147). Generally

speaking, well-managed grass orcharding is to be favoured for orchards that are in, or are entering, their most productive phase, since not only is such conducive to good cropping without excessive vigour, but also conditions of harvesting are seldom so pleasing where soil cultivations are practised as they are under grass. Nevertheless, some are encouraged to believe that shallow surface cultivations together with suitable manuring are practicable means by which an arable cherry orchard can compete satisfactorily with the grass orchard. This is a doubtful generalisation but it is probably true of orchards that tend to suffer from effects of drought early in the summer.

APPLES.

A number of factors combine to determine the best cultural management to give to apples at any particular phase of their existence. The form of management, whether grass or arable decided upon at one stage, due to a particular condition of growth or behaviour, may not apply at another, and changes in management may have to be made accordingly.

The apple grower endeavours to secure the dual requirement of heavy crops regularly and quality fruit of high competitive value. It is necessary, by constant observation both of the tree vigour and of the condition of the fruit, to be able to determine the form of management most suited to ensure this dual requirement. Trees of the same variety of apple grown on the same rootstock and under identical conditions, with increasing age and weight of crops, invariably yield fruits of markedly different appearance. Whereas, for the first four or five years (whilst trees are relatively unproductive and whilst it is more important to achieve increases in tree dimension than crop of a particular quality range) arable conditions are required, once this phase has passed, various factors should be taken into account in determining the forms of management. The chief factors to be considered are the amount of new season's growth (i.e. vigour), the variety, together with soil and climatic conditions.

Arable Management.

The circumstances under which arable management should be favoured for trees that have passed the juvenile development stage and from which crops of fruit of the required quality type should be forthcoming are : (i) Vigour, (ii) Variety, (iii) Soil Moisture.

(*i*) *Vigour*. It is seldom wise to apply apples to grass culture whilst the conditions of vigour are only poor to moderate,

because a change over from arable to grass management is usually accompanied by a pronounced decline in vigour for 2–3 years. This ruling should certainly be adhered to when the cause of the undervigorous state is attributable to : (*a*) low nitrogen, (see p. 141), (*b*) Low moisture, or (*c*) Dwarf root-stock (see p. 84).

In view of the more favourable relative balance or increase in availability of mineral constituents from grass management this treatment is justified to some extent, by results, when the undervigorous state is due to mineral deficiencies such as those of Potash, Magnesium or Iron or where Nitrogen is known to be high. Nevertheless even under circumstances such as this the preferable and fundamental approach is first to correct a deficiency ; and this is usually done by applications of an appropriate fertiliser (in the case of Iron, favourable response cannot be gained by soil application (see p. 127)), and to apply to grass as soon as conditions of tree vigour permit. Sometimes it becomes advisable to return from grass to arable management, and this especially applies to trees that are markedly under-vigorous, where crops are highly coloured and individual fruits are small and where the bark is highly coloured (i.e. reddish yellow).

(*ii*) *Variety*. Some varieties, notably those of the early culinary type such as Early Victoria (also called Emneth Early), Grenadier and Lord Derby, should seldom be applied to grass management even when vigorous growth is being made. The essential commercial value of these varieties lies in the fact that they are capable of producing large fruits early in the season. In order to secure full advantage of this commercial value, the trees must be maintained in a vigorous state of growth and have adequate soil moisture at least to the end of July. Not only do the fruits gain size less quickly under grass, they are often yellow in appearance instead of being that attractive green associated with these culinary sorts.

(*iii*) *Soil Moisture*. Under some conditions the application to grass management is inadvisable even for trees making tolerably vigorous growth. This is because of the probable drought effects that would result. This may be said to apply to shallow soils and light sandy soils with poor moisture-holding capacity. Varieties such as Bramley's Seedling and Worcester Pearmain are often grown at their best under grass, even when the rainfall is low, provided the soil is of good depth and capable of holding moisture. In view of this, it is pointed out that the average annual rainfall does not give a true index,

in itself, of the probability of drought effects. Factors such as soil depth and texture are of great importance in arriving at a correct decision as to whether grass management would be advantageous or detrimental.

The tillage provision for apples that require arable management differs from that for the clean cultivation of strawberries and other soft fruits. One of the unsatisfactory features of growing a soft fruit intercrop between apples after the trees are 4–5 years old, is that the intercrop determines the form of soil management. For apples, clean cross-row cultivation is needed during early Spring and it should be maintained until the end of July. Small squares are unavoidably left uncultivated, it being impracticable to get right close up to the tree-trunks when horse- or machine-drawn cultivators are used. While trees remain small, weeds should be prevented by hand hoeing from becoming established on these squares early in the growing season. The management procedure between apples is the same as for pears (see p. 111). After July, cultivations are dispensed with and weeds are allowed to grow. A good mat of annual weed not only safeguards against a rapid depletion of soil organic matter, but is also of considerable benefit both to the appearance and the storage quality of the fruit produced. Some growers actually sow a late cover crop such as mustard, tares or a mixture of oats and tares when they have reason to be dissatisfied with the bulk of herbage that would be derived from weeds. Often weeds are so tall by the time the crop has to be gathered, that it is more or less necessary to mow them down, due to the physical discomfort otherwise experienced in gathering the fruit. Mowing is done either by hand or with a mechanical scythe.

Grass Management.

The circumstances under which grass management is needed or may be adopted, for trees that have passed the initial juvenile development phase and from which crops of fruit should be forthcoming are: (i) *Vigour*, i.e. when considerable shoot growth is made from year to year and the trees are deemed vigorous or excessively vigorous. (ii) *Variety*, i.e. for sorts that yield large, poor quality dessert fruits under arable conditions and for certain sorts that are normally suited to a wide range of management conditions. (iii) *Soil Moisture*, i.e. when moist soil conditions prevail during the Summer months in contrast to conditions that dry out rapidly.

(*i*) *Vigour*. With most apple varieties, very vigorous growth

is not conducive to good cropping, and so application to grass management is one of the most effective means by which vigour can be checked and productivity enhanced. Excessive new season's growth, or, as it is generally termed, excessive vigour, may be attributable to one or more causes such as : (*a*) deep fertile soil, (*b*) heavy manuring, (*c*) vigorous rootstocks (see p. 86), (*d*) severe pruning (see p. 150). Grass management is most likely to be the best form of management when excessive vigour is due to the combination of (*a*) and (*c*). Although application to grass may be a valuable means of bringing about a more desirable state for trees that have been heavily manured or severely pruned, such might only apply for a few years and it should be appreciated that under conditions of less manuring or light pruning a continuation of the arable form of management might be preferable. At least, care should be taken when excessive vigour prevails, not to leave off manuring and pruning and to apply to grass all in one season, because it is not unlikely that the condition would then be very speedily reversed from excessive vigour to deficient vigour.

(*ii*) *Variety*. Where questions of drought and lack of vigour do not arise, there are some varieties that can be managed equally well under systems of grass or arable culture. The varieties Bramley's Seedling and Newton Wonder (see p. 57) are classical examples. Nevertheless heavier manuring is normally required for the first few years after application to grass than for trees of the same variety under arable conditions. The fruits of some varieties, notably dessert, have only poor market value when they are very large, soft-textured and under-coloured. Well-coloured fruits of Worcester Pearmain and Laxton's Superb are required, and this applies more or less to most dessert sorts. Very large apples, predominantly green in colour, are hardly countenanced as of dessert quality. Whilst it is true that the juicy aromatics of the Cox's Orange should be cultivated and, on account of this, arable conditions are often to be preferred for this sort, it is also true that large under-coloured specimens, which have poor keeping quality and poor dessert value, are not favoured. When it is found that under arable conditions dessert apples are too large, of poor colour and of poor keeping quality, considerable benefits to size, colour and keeping value can be brought about by application to grass management.

(*iii*) *Soil Moisture*. Not only do soils applied to grass management dry out sooner than under arable management, they also take longer to become saturated with water during

the Autumn and Winter months. In view of this, it will be appreciated that the expedient of grassing down is a valuable means of removing soil water when it is present in excess during the Spring and Summer, and also of delaying early saturation during Autumn. Very often, under soil conditions that are moist during the entire growing season, vigorous growth results, and when this happens, varieties like Worcester Pearmain and James Grieve are very subject to the disease Apple Canker (see p. 224). More often than not, the best means of reducing, if not controlling, this disease is by applying to grass management, in place of arable, and temporarily withholding application of nitrogenous fertilizers. When changing from arable to grass management, a procedure similar to that described for cherries (see p. 112) should be followed.

Once grass is well established, it is essential to keep it short during the Spring and early Summer months. This may be done by frequent mowing operations or by sheep. In plantations of bush trees, mowing is essential and the tool most favoured for the purpose is the tractor-drawn gang-mower. Even for Half-Standard and Standard orchards fruit growers are showing a distinct preference for mowing. Fruit growers, unless they are engaged in other branches of farming as well, generally do not care to have sheep. When sheep are employed for keeping the grass tight, it is more or less essential that there should be grazing for them other than provided by the orchards. It is advisable to take sheep out of orchards for a few days when Arsenate of Lead has been employed in the spray mixture (see p. 289), furthermore, sheep are not wanted in orchards, near and during harvesting. The number of gang-mowing operations necessary during the course of a season varies from year to year and depends upon how quickly the grass grows. On average, mowing should be done once fortnightly during April and May and rather less than this during June and July. After July, mowing may be discontinued as a regular routine, only doing it as occasion demands, so that the grass does not become too tall and therefore difficult to deal with by gang-mower. The mown grass cuttings should be allowed to rot where they fall, and under no circumstances should grass be allowed to grow tall and be taken away as hay. Only under the exceptional circumstances of extremely vigorous trees could the taking of a single crop of hay be justifiable. Instances are known where the removal of a single hay crop has resulted in a severe check to the vigour of the trees and heavy manuring has been needed to restore the situation.

CHAPTER VI

THE NUTRITION AND MANURIAL TREATMENTS OF FRUIT CROPS

From cultivation we proceed to nutrition. Reasons are given for the employment of manures, both inorganic and organic and those commonly used are detailed. Symptoms of mineral deficiency and corrective treatments are described and suitable manurial treatments are outlined for the various fruit crops.

The primary aim of a fruit grower is to produce the heaviest possible crops of good-quality fruit regularly. The factors of crop yield, quality and regularity should be considered collectively since, so far as is possible, weight should not be borne at the expense of good market quality, nor at the ability to repeat the performance during subsequent successive seasons. This is a high standard of efficiency to aim at, and it is not likely to be achieved unless the various fruit crops are maintained in a state of growth suited to their respective needs. Needless to say, this cannot be done unless their nutrient needs are satisfied and this in turn implies that the soil, on which they are grown, must hold and be capable of supplying in sufficiency both water and the essential mineral elements. The production of crops over a number of years from the same soil, inevitably results in a depletion and in course of time a deficiency of one or more essential mineral elements. On some sites deficiency conditions may occur early on in the life of the crop whilst on others several years may elapse before such is the case. Sooner or later, and for preference before acute need is apparent, a form of replenishment by making applications of suitable mineral fertilizers to the soil becomes necessary.

REASONS FOR USING INORGANIC FERTILIZERS SUPPLYING MINERAL SALTS.

One of the main reasons for manuring fruit crops is to prevent the occurrence of mineral deficiencies that impair

productive efficiency. Soil applications are made of fertilizers supplying elements such as nitrogen, potassium, phosphorus, calcium and magnesium for which the need is usually greatest and deficiency most likely. Elements such as iron and manganese, deficiencies of which are likely to occur in soils where lime is excessive, cannot be supplied satisfactorily by soil application, so they are supplied by tree injection methods or, in the case of manganese, by spraying (see p. 277).

The foremost consideration when applying fertilizers is to supply the immediate seasonal requirements of those elements of which there is greatest need ; and when this is a regular procedure, it is hardly likely that deficiency problems in respect of those elements will arise, although the policy may savour of a hand to mouth existence. Even before the important objective just outlined can be achieved, it is necessary for a grower to have some idea of the respective needs of his different crops. This information is usually obtainable by chemical analysis of both soil and plant material and by the visible appearance of the growing crop.

An important secondary reason for the application of fertilizers and manures, is to secure a reserve build-up of essential mineral elements. However, this can only be done to advantage within certain limits and in respect of certain elements. An excessive build-up of mineral matter in one direction may lead to an apparent deficiency in another. For instance, an excess of calcium may in some cases be responsible for an iron deficiency, and in others, where conditions of poor drainage occur, a manganese deficiency (see p. 125). An excess of potassium leading to luxury consumption of this element, has been known to aggravate symptoms of magnesium deficiency. This serves to stress the point that it is wise to secure a balanced build-up of certain essential elements. Nevertheless an element such as nitrogen is not readily held by the soil, and it is futile to attempt to secure a level in excess of that required to meet the seasonal needs of the crop that is being grown. An over-supply of readily available nitrogen is usually accompanied by detrimental results.

It is clearly evident that if money is to be spent to good purpose on fertilizers, a grower must know in general terms what is needed by the various crops he is growing. He must also know how that need can be met. An estimation of the nutritional needs of a crop is determined by the kind of crop that is being grown, the state of growth, whether good, excessive or poor, the appearance of the foliage, whether healthy or

abnormal and the condition of the fruit, whether size and colour are satisfactory or not. The response of a crop to its environment, as exhibited by its visible characteristics, is an invaluable guide to its nutritional needs. It is a tenet of good farming to learn the language of plants from the varied visible manifestations of leaves, shoots, fruit and wood character. A more matter of fact method of determining the needs of crops, in respect of certain elements, is based on a chemical analysis of soil and plant material. The grower who has taken the pains to familiarise himself with the visible symptoms of mineral deficiencies, so far as they can be determined, and who periodically, say once every three or four years, submits soil samples to the Soils Chemist of his province in the National Agricultural Advisory Service for analysis, is in a position to employ fertilizers to good advantage. Naturally this presupposes that a grower has a working knowledge of the various fertilizers, what they supply and the quantity required per acre to meet a given need.

REASONS FOR USING MANURES SUPPLYING BOTH ORGANIC MATTER AND MINERAL MATTER.

There is another side of the nutritional story which is barely less important than that concerned with the mineral status of both soil and plants. It concerns the very nature of the soil, the rooting medium for the fruit crops, or as it might be termed, the vehicle by which the nutrient needs are supplied. For some crops, it is particularly desirable that the soil should possess an easily workable character and in the event of tendencies to set hard, i.e. to clod or pan, it may seriously add to the physical difficulties of maintaining "clean" cultivation. The ease with which a soil can be worked, especially for crops that have to be maintained under clean cultivation, is important. In addition to this, the capacity of a soil to hold water and yet to remain well aerated are features that growers would do well to preserve and foster. At least it is highly desirable to guard against any progressive deterioration of a soil in respect of irregularities both as far as Summer drought and Winter wetness are concerned. A long term manurial treatment should therefore not only be designed to supply essential mineral matter, but also to maintain a suitable physical state. The physical state of a soil although bound up with questions of depth and with the texture of geological material which has contributed the mineral part of the soil, is also closely bound up with the organic matter it contains.

Methods of Supplying Organic Matter.

Under a system of clean cultivation there are various factors that play a part in depleting soil organic matter. It falls to the grower to make good this loss by various means, or at least to see to it that the loss of organic matter is not such as to result in a general deterioration of his crops. Organic matter may be increased by various means, viz: (i) By the application of organic manures, (ii) by growing a permanent cover crop, such as grass or clover, (iii) by growing and ploughing in green cover crops, (iv) by surface mulching with fresh or composted straw.

The relative merits of the various ways of supplying organic matter depend primarily upon the kind of fruit crop that is being grown and secondarily upon the materials that are most readily obtained. For soft fruits, chief dependence must be placed upon the application of manures, although to a limited extent green cover crops may be employed for bush fruits like blackcurrants and cane fruits like loganberries and blackberries. Tree fruits lend themselves to a greater variety of treatment than soft fruits, the straw mulch, applied organic manures, and temporary and permanent cover crops may all under different circumstances be employed with success.

When a straw mulch system of supplying organic matter is adopted, it must be borne in mind that if it is allowed to decompose unaided, a nitrogen deficiency is likely to occur. Unlike farmyard manure, where the straw is partially rotted and supplied with nitrogen in the animal residues, a straw mulch must pass through the whole process of decomposition whilst on the soil, and soil bacteria will require nitrogen to effect that decomposition. In order to safeguard against nitrogen deficiency, which will be indicated by symptoms showing in the growing crop, it is necessary to apply nitrogen fertilizer in sufficiency (see p. 138).

FERTILIZERS AND MANURES COMMONLY USED.

(i) Those supplying Nitrogen.

Nitrate of Soda ..	15%	Nitrogen	Inorganic.
" Nitro-chalk " ..	15½%	,,	Inorganic.
Sulphate of Ammonia	21%	,,	Inorganic.
Shoddy	2–12%	,,	Organic.
Hoof and Horn Meal	10–14%	,,	Organic.
Rape Meal	4–6%	,,	Organic.
Feathers	9%	,,	Organic.
Dried Blood	12–14%	,,	Organic.

(ii) Those supplying Phosphorus.

Superphosphate ..	30%	Phosphate	Inorganic.
Basic Slag	15–45%	„	
Steamed Bone Flour..	55–69%	„	Organic.
Dissolved Bones ..	33–35%	„	

(iii) Those supplying Potash.

Sulphate of Potash ..	48–50%	Potash	Inorganic.
Muriate of Potash ..	40–06%	„	

(iv) Those supplying Magnesium.

Magnesium Sulphate .. 20–40% Magnesium.

(v) Those supplying Lime.

Hydrated Lime.
Ground Limestone.

(vi) Those supplying more than a single essential element.

	Nitrogen.	Phosphate.	Potash.
Farm Yard Manure ..	·5%	·2%	·6%
Straw	·5%	·2%	1%
Meat and Bone Meal	5–10%	5–20%	—
Peruvian Guano ..	5–14%	20–40%	2–4%

Ground Magnesian Limestone. 20–40% Magnesium.
Compound Fertilizers as supplied by manure merchants.
5–10% Nitrogen. 10–30% Phosphate. 5–18% Potash.

DEFICIENCY SYMPTOMS.

When nutritional needs are satisfied, such is registered by the general appearance of the respective fruit crops, especially during the Summer months. Similarly a shortage of an element essential to the satisfactory development of a particular crop is registered by visual symptoms. Each element performs specialised functions which cannot be totally undertaken by any other element, and when one or other is in short supply, and the synthesis of all in combination is affected in this or that direction, the specific symptoms which generally appear are enough to denote the particular element that is lacking. The appearance of a growing crop is one of the best guides by which nutritional status is indicated. The deficiency symptoms commonly met with are due to need for Nitrogen, Potassium and Magnesium. Although these deficiencies are widespread,

potassium and magnesium deficiencies are most likely to occur on light soils from which the base elements, i.e. calcium magnesium and potassium, are readily removed In addition to nitrogen, potassium and magnesium deficiencies, iron and manganese deficiencies are of common occurrence on highly calcareous soils, the latter occurring especially where drainage is poor (i.e. the land is too wet). Symptoms are exhibited by foliage during July and August for tree fruits, and rather earlier than this for soft fruits.

1. Nitrogen Deficiency.

Foliage: Pale green to yellow, small.

Shoots: If any, comparatively few; short and thin.

Fruit: Small, hard, highly coloured for the variety grown.

Bark: Highly coloured, i.e. orange-red colourings especially on sunniest side of trees.

2. Potash Deficiency.

Foliage: Small and sparse in severe cases, brittle. Margins dead, dead portion, brown to greyish-brown in colour (referred to as *leaf scorch*). Usually associated with some yellow-bronze colourings with central portion darker green. Scorch symptoms appear rapidly during hot, dry weather, although may not show at all if deficiency is only mild.

Shoots: Number and length restricted. In severe cases, severely restricted.

Trees and Branches: Symptoms are seldom evenly distributed, some individual trees and branches are generally much more severely affected than others.

Fruit: Much reduced in size, dull and immature in appearance.

3. Magnesium Deficiency.

Foliage: Small in severe cases, when this stage is reached, other symptoms may be masked. Seen on tree fruits during August when severe defoliation takes place, especially on new season shoots proceeding from the base upwards. Symptom colours vary from creamy to yellow-bronze-red-purple; these occur more in soft fruits than tree fruits. In gooseberries a broad marginal band varying from creamy to yellow-bronze-red. In blackcurrants, the centre parts are of purple colour and the leaf margins remain green for a much longer period. In strawberries, the centre portion and margins are red tinted and the older leaves are yellow. Dead, brown portions are the most pronounced symptoms of tree fruits. The dead portions

mostly occur in between the main lateral veins and the trouble is referred to as *interveinal necrosis* or *interveinal scorch.* The scorch may be confined to the central portion near the midrib, as a circular band in between the midrib and margin, or it may start on the side margin and extend in between the veins towards the midrib. In some tree fruits, notably cherries, plums and some apples, the scorch is preceded by a yellowing, and in the case of cherries, there is much red tinting.

Shoots: Tend to be thin and elongated in mild cases. In severe cases few, spindly or absent. From late July onwards often bare of leaves, save for a few at tips whilst fruit is still on affected trees.

Trees and Branches: May be almost completely defoliated whilst crop is still on, when this occurs both main stem and branches on sun side liable to be blistered by the sun.

Fruit: Small, dull and immature in appearance.

4. **Iron Deficiency.**

Foliage: Yellow, usually bright yellow, extending from apical leaves downwards, sometimes affecting the entire foliage. In severe cases, leaf margins die, becoming pale-brown and the remainder of the leaf is entirely yellow. In less severe cases, with the exception of pear varieties, main, lateral and sub-lateral veins remain green whilst the rest of the leaf is yellow.

Shoots: In mild cases, tip leaves of shoots yellow; lower ones normal colour.

Fruit: Reduced crops. Small size. Fruits of apples and pears, pale-green-yellow with a red flush above the normal.

5. **Manganese Deficiency.**

Foliage: In mild cases, marginal and interveinal yellowing; with pears, less deeply indented between the veins than with cherries and apples. Midrib and main lateral veins usually remain green, together with some of the surrounding leaf tissue, appearing as broad bands of green surrounded by yellow. In pears and cherries, the green portion is usually dull, rather than bright green. In severe cases, leaves are completely yellow often with marginal necrosis. With tree fruits, old leaves and spur leaves are more severely affected than younger ones. Yellow colouring usually less bright than for iron deficiency. With soft fruits, it is not easy to distinguish between this and iron deficiency, although

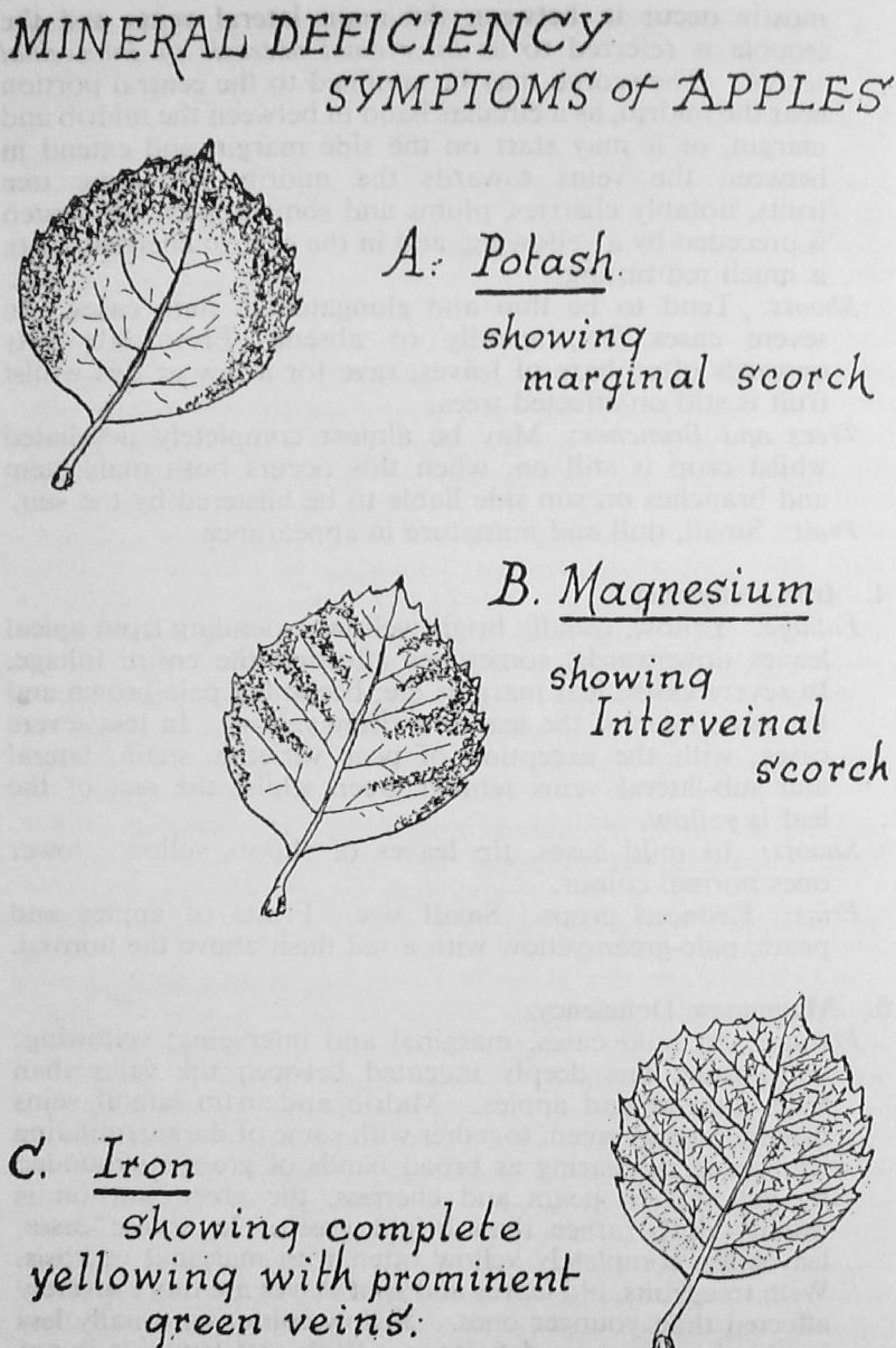
MINERAL DEFICIENCY
SYMPTOMS of APPLES
A: Potash.
showing
marginal scorch
B. Magnesium
showing
Interveinal
scorch
C. Iron
showing complete
yellowing with prominent
green veins.

Fig. 8

with manganese deficiency the sub-lateral veins seldom show green.

CORRECTING DEFICIENCIES.

A mineral deficiency can usually be corrected by making applications to the soil of a fertilizer supplying the element required. Hence nitrogen may be supplied through a fertilizer such as "nitro-chalk," potash through sulphate of potash and magnesium through magnesium sulphate or ground magnesian limestone. Ground magnesian limestone may be employed for acid soils although it is generally unwise to use it on highly calcareous soils. Whereas a nitrogen deficiency may be corrected within a short space of time, say a few weeks when suitable conditions of tillage and moisture apply, both potash and magnesium deficiencies, when severe, may take anything from two to four years to correct. A nitrogen deficiency can normally be corrected on the application of 5 cwt. "nitro-chalk" per acre or an equivalent dressing of a readily available nitrogenous fertilizer. A potash deficiency normally requires application of 4 cwt. sulphate of potash for several successive years, and a magnesium deficiency of magnesium sulphate (as Epsom's Salts) at 8 cwt. per acre for a few years. One of the less frequent forms of magnesium deficiency occurs when the potash status is extra high; and although it is then the correct procedure to apply a fertilizer containing magnesium, the response is hastened by temporarily withholding potash applications.

Reference has already been made (p. 120), to the fact that deficiencies of iron and manganese occur on highly calcareous soils. In such cases, applications to the soil of salts containing these elements are not likely to be of any benefit because soil conditions render them unavailable to growing crops. Manganese deficiency can readily be corrected by spraying the foliage with manganese sulphate at a concentration of 5 lb. to 10 lb. per 100 gal. of water. The spraying is done during Spring soon after blossoming, when there is a goodly supply of foliage and a correction of the deficiency is obtained within two or three weeks. For tree fruits, iron deficiency is best dealt with by inserting tablets of ferrous sulphate into the woody stems or branches by what is termed an injection technique, giving correction within a few weeks. Tablets of manganese sulphate may also be used to correct manganese deficiency although the response is rather slower than for iron. Solid injection of this description is best done during Winter and early Spring. Some

risk of foliage injury is likely when the operation is carried out during the Summer months, especially if dosage is on the heavy side (for particulars of injection technique, see pp. 275–279).

MANURIAL PROGRAMMES.

It is evident that where such diverse factors as organic matter, mineral status, kind and varieties of fruit, soil type and climate occur both separately and in combination and all are features which affect the choice of correct manurial treatment, no single manurial prescription can be given to satisfy every circumstance. It is proposed, therefore, to state in general terms what are the normal manurial requirements for the various kinds of fruits, together with certain desirable modifications to suit conditions of fairly common occurrence.

Pre-Planting Considerations.

Just as planting should not be done irrespective of soil and site, so it should not be done unless the nutritional conditions will satisfy the needs of the proposed crop for at least a short period after planting. Although it is possible, with the majority of fruit crops, to gain favourable responses following suitable manurial applications to fruit crops planted under conditions of faulty nutrition, it is generally a slow process. A short-term crop like strawberries must be excepted from this generalisation since they seldom make good if the initial planting conditions are unfavourable. A suitable nutritional status should be obtained prior to planting. This is a good axiom for all fruit crops, especially soft fruits and most especially strawberries, although their varying needs govern whether the particular emphasis of treatment is in one direction or another. For all crops, there should be no lack of potassium or magnesium and in the case of dessert apples, dessert gooseberries, raspberries, loganberries, strawberries, redcurrants, pears (vars. Conference and Early Market), a higher potash level is required than for culinary apples, plums, blackcurrants and blackberries. For strawberries, it is necessary to have a higher phosphate level than for other fruits. Potassium should be supplied by applying sulphate of potash at 4 cwt. per acre so long as deficiency conditions prevail. Magnesium is supplied by magnesium sulphate at the rate of 8 cwt. Epsom Salts per acre and phosphorus by superphosphate at the rate of 4 cwt. per acre. Under acid conditions where a magnesium deficiency exists, Ground Magnesian Limestone at 1 ton per acre should be applied. It is seldom necessary to apply inorganic nitrogenous

fertilizers before planting, unless it be to assist in the decomposition of strawy, vegetable material; for decomposition of straw results in a nitrogen impoverishment of the soil which must be prevented by the addition of nitrogen. Some few years may elapse after planting before nitrogenous fertilizers need be applied to tree fruits; but soft fruits such as blackcurrants, loganberries and blackberries are likely to benefit from applications, if not before, at least soon after planting. Liming should be done cautiously, steps being taken to reduce any marked acidity while maintaining a slightly acid condition. Blackcurrants, redcurrants and gooseberries and loganberries are less likely to thrive under acid conditions than most crops. Strawberries and dessert apples normally thrive on soils that are fairly acid; in the case of the strawberries, applications of lime immediately before planting or after planting may have damaging results unless the previous conditions are markedly acid, it is preferable therefore to plant strawberries one or two years after the application of lime.

Whereas tree fruits seldom derive the best benefits from the applications of bulky organic manures (such as farmyard manure or shoddy) before planting, application is normally of great benefit to soft fruits, especially on soils that have been applied to arable management for several years previously and when soil textures are of the light (sandy) type.

A well-tested practice for soft fruits and one that is substantiated by research, is the preplanting application to the land of farmyard manure at the rate of 20–40 loads per acre. This advice presupposes that livestock is kept whereby a balanced husbandry can be maintained. As a first measure, the dung should be disced in, rather than ploughed in. A surface mulch is more likely to be of assistance for subsequent cultural operations and moisture conservation than manure at the bottom of a furrow. When no dung is available, there are various less satisfactory alternatives such as: (i) application of composted straw at 20–40 loads per acre. (ii) Application of straw direct to the land at 2–3 tons per acre plus 5 cwt. "Nitro-Chalk" or 3 cwt. sulphate of ammonia (see pp. 122, 138). Long straw is readily broken by running a heavy disc harrow over it when it is stiff with frost. (iii) Application of shoddy at 2 tons per acre.

The disadvantage of composting is its high cost. The method of applying straw direct to the land is becoming increasingly favoured. When this course is adopted, it is preferable to apply the straw during the Winter preceding planting, it being impracticable to do so during the Autumn of planting. Similarly

shoddy should be applied several months in advance of planting. In between the application and the planting of the fruit crop, a crop that will be cleared early may be grown, after which a cover crop such as oats, tares or mustard for ploughing-in green may be broadcast.

Supposing the site to be planted has, for several years previously, been pasture, it is seldom necessary to apply organic manures additional to that supplied by the decaying herbage. As a rule, it is unwise to follow immediately upon the ploughing of an old pasture with strawberries, unless there is good reason to believe that pests such as wireworm and leather jacket are not likely to be troublesome.

There is an apt saying, " nothing is so costly as failure " and one would hasten to add that neither is it to the fruit grower's advantage to make success as expensive as possible. Although most growers would do well to spend more money on manures much that is spent is wasted. Manuring must be done with full knowledge if it is to be advantageous and economic. There is really no need for manuring to be haphazard and based upon pure guesswork, since if any doubt exists in the mind of a grower about the nutritional status of this or that site, it points to the advisability of calling in someone technically qualified to make an examination, and, if needs be, to submit soil samples for the purpose of analysis.

A grower having taken note of the fact that some plums were doing well on a soil of moderate depth, and overlying chalk, generously limed another site prior to planting. Since the newly planted plum piece failed to thrive according to expectation, further limings were given, and on reckoning it was apparent that within the course of a few years something like 100 tons of lime per acre had been applied. The foliage of the plums was very yellow and the trees at 10 years old failed to crop. Upon examination, it was evident that a violent manganese deficiency had been induced, due primarily to an excess of lime.

MANURING SOFT FRUITS.

1. Strawberries.

Luxuriant growth is not required, as it is not conducive to heavy yields, and excessive foliage is detrimental, so far as ripening and quality are concerned. Thus nitrogen should be at a medium level whereas phosphates and potash should be in good supply. The physical conditions of a soil should be

such as to hold moisture well during the early Summer months; it should be of a crumbly structure so that it can easily be worked by cultivators. Thus a soil well supplied with organic matter is desirable. A well-conceived pre-planting treatment is far more likely to benefit strawberries than post-planting treatments (see p. 128). There is not sufficient evidence to indicate that manuring strawberries after planting is merited, unless during the Autumn of the maiden year when 8–10 cwt. per acre of Meat and Bone Meal could be applied.

2. Redcurrants, Gooseberries, Raspberries.

Good growth is required from these crops each season, although luxuriant growth is not advantageous. Steady growth of the hardy type is to be preferred to the over vegetative type, since the latter, in the case of raspberries, is not conducive to the most productive cropping, and with gooseberries and red-currants, great difficulty is often experienced in establishing bushes because the young shoots can be blown out during high winds. Under reasonably fertile conditions, inorganic nitrogen should be omitted during the early years; and in the case of redcurrants and gooseberries, the application of bulky organics may be deferred until the bushes are established. For all these crops it is essential to maintain potash in good supply.

Nitrogen. Once yearly applications have to be made during Autumn and Winter to supply nitrogen. Organics such as Hoof and Horn at 2–3 cwts. per acre or Meat and Bone Meal at 3–5 cwt. per acre or Rape Meal at 10 cwt. per acre are satisfactory. In addition to this, under growing conditions that are relatively dry, 1–1½ cwts. per acre of "Nitro-Chalk" may be used with good effect during late Winter (February–March). In general, inorganic nitrogen should be avoided where as a result either of high rainfall or of high watertable, growing conditions are moist. Give periodically, say once every 3–4 years, an application of farmyard manure at 10–20 tons per acre. During the years that this is done, other organic manures may be omitted.

Potash. Should be applied regularly each Autumn as sulphate of potash at 1–2 cwt. per acre, increasing to 4 cwt. per acre under deficiency conditions. It may be omitted under conditions well supplied with available potash.

Phosphates. May be supplied every alternate year during Autumn to Spring as superphosphate at 3–4 cwt. per acre, or some equivalent in the form of other phosphatic fertilizers, although annual applications are advised so long as there is a

phosphate shortage. When Meat and Bone Meal is used as the source of nitrogen and phosphate, it is seldom necessary to apply other phosphatic fertilizers.

Magnesium. Under deficiency conditions, this element should be applied as magnesium sulphate at 8 cwt. of Epsom Salts per acre, per annum, during Autumn to Spring. On light (sandy) soils, periodical applications should be made, say once every 3 or 4 years, at 2 to 4 cwt. per acre. On acid soils, an application at 1 ton per acre of Ground Magnesian Limestone may be made during Autumn to last until further liming is necessary. Should a magnesium deficiency persist in between applications of Ground Magnesian Limestone, applications of magnesium sulphate should be made for a few successive years at the rate of 4 cwt. per acre.

Calcium. Under conditions of more than moderate acidity, Autumn application of Hydrated Lime or Ground Limestone should be made to bring the surface soil to the slightly acid state. Where Ground Magnesium Limestone has been applied there should be no need to apply other lime containing fertilizers (see recommendations concerning magnesium in the foregoing paragraph).

SUMMARY OF TREATMENT.

Autumn to late Winter applications (i.e. November to March).

Hoof and Horn, 2–3 cwt. per acre, *or*
Meat and Bone Meal, 3–5 cwt. per acre, *or*
Rape Meal, 10 cwt. per acre.
Farmyard Manure, 10–20 tons per acre, every 3–4 years.
"*Nitro-Chalk*," 1–1½ cwt. per acre in dry situations.
Sulphate of Potash, 1–2 cwt. per acre; 4 cwt. per acre under deficiency conditions.
Superphosphate, 3–4 cwt. per acre every second year; annually under deficiency conditions. Omit when supplied with nitrogenous manures.
Magnesium Sulphate, 2–4 cwt. per acre on light (sandy) soils, every 3–4 years; 8 cwt. per acre annually under deficiency conditions, *or*
Ground Magnesian Limestone at 1 ton per acre under acid conditions.
Hydrated Lime or Ground Limestone to bring soil to a slightly acid state where no magnesium deficiency exists.

3. Blackcurrants, Loganberries, Blackberries.

Vigorous growth is required by these crops, and a rather higher nitrogen level should be maintained than for the crops

already discussed. Although organic manures, preferably of the bulky type, should provide the main basis for the manurial treatment, blackcurrants in particular respond favourably to appreciable dressings of inorganic nitrogen. Good responses will be obtained from a lower potash level than is required by most other soft fruit, although this should not be taken to mean that their potash requirements are negligible. As with strawberries, there is good reason to believe that phosphates should be in good supply. An all round high state of soil fertility is needed for these crops, right from the time of planting.

General. Periodical autumnal applications, say every third or fourth year, of farmyard manure, especially for blackcurrants at 15–30 tons per acre. Green manuring either in the form of oats and tares sown during July and August, or annual weeds to be ploughed in during late Autumn.

Nitrogen. Periodical Autumn applications of Shoddy at 1–2 tons per acre or feathers at 1 ton per acre, or other bulky manures, where farmyard manure is not available. Annual, late Winter applications of inorganic nitrogen such as "Nitro-Chalk" or the equivalent, at 3–4 cwt. per acre. When bulky organics supplying nitrogen are not available, Hoof and Horn applied during Autumn at 5–6 cwt. per acre or Meat and Bone Meal at 8–10 cwt. or Rape Meal at 15–20 cwt., should be applied in which case only 1–2 cwt. of "Nitro-Chalk" need be applied. With established blackcurrant bushes, a further application of "Nitro-Chalk" at 1–2 cwt. per acre, made immediately the crop is harvested, gives beneficial results. It is futile to give this application if the Leaf Spot disease is serious (see p. 212).

Potash. Annual Autumn applications of sulphate of potash at 1 cwt. per acre should be made unless potash is known to be in good supply, in which case it may be reduced to ½ cwt. per acre, or even omitted periodically. Alternatively, 2–4 cwt. per acre should be applied when there is evidence of potash deficiency.

Phosphate. Annual application of superphosphate at the rate of 3–4 cwt. per acre during Autumn to late Winter or the equivalent supplied in some other form. In the event of substantial application of organic manures containing phosphate, other phosphatic fertilizers need not be applied.

Magnesium. Periodical Autumn or Spring applications of magnesium sulphate as Epsom Salts at 4–8 cwt. per acre under normal conditions or annual applications under deficiency conditions. When soil conditions are markedly acid, Ground Magnesian Limestone applied during Autumn at 1 ton per acre may be used to replace the magnesium sulphate.

Calcium. Under conditions of more than moderate acidity, Autumn application of lime should be made (see recommendations under 2 above).

SUMMARY OF TREATMENT.

Autumn to late Winter applications.

Farmyard Manure, 15–30 tons per acre every 3 or 4 years.
Green manuring, during Autumn.
Shoddy at 1 to 2 tons per acre, if no farmyard manure, *or*
Feathers at 1 ton per acre.
Hoof and Horn at 5 to 6 cwt. per acre during years intervening application of farmyard manure, etc., *or*
Meat and Bone Meal at 8 to 10 cwt. per acre, *or*
Rape Meal at 1 ton per acre.
" *Nitro-Chalk* " at 1 to 2 cwt. per acre or 3 to 4 cwt .per acre when no nitrogen supplied as organics.
Sulphate of Potash at 1 cwt. per acre. 2 to 4 cwt. per acre under deficiency conditions.
Superphosphate, 3 to 4 cwt per acre; omit when phosphate is supplied in other manures.
Magnesium Sulphate at 2 to 4 cwt. per acre every 3 or 4 years; annual application under deficiency conditions, *or*
Ground Magnesian Limestone at 1 ton per acre under acid conditions.

Summer application for Blackcurrants.

" *Nitro-Chalk* " at 1 to 2 cwt. per acre immediately after crop is picked.

MANURING OF TREE FRUITS.

1. Apples.

Whilst trees are young and unproductive, most varieties should be treated similarly, because the requirements are more or less identical, viz., that productive trees should be formed with the least possible delay. Such differences as are required are attributable to soil differences more than to varietal differences. With increasing age, the emphasis is placed upon crop-production rather than tree-development and factors such as weight of crop and fruit quality are of paramount importance. This stage is arrived at sooner with close planted trees, such as Cordons and Dwarf Pyramids, than with wide plants such as Standards. There are four main quality groups, two of which are in the dessert apple class and two in the culinary apple

class. The requirement for some dessert apples, such as Worcester Pearmain, is high colour and firm texture, and while this is important with such varieties as Cox's Orange Pippin, a rather juicier apple with more aromatic flavour is sought. The requirement for early culinary apples, with short-keeping qualities, such as Early Victoria and Grenadier, is green apples which gain large size early in the season. The classic late-keeping culinary apple is Bramley's Seedling and whereas reasonably good size is wanted, size must not be pursued so much as to conflict with good storage quality.

(i) Newly Planted and Young Trees.

Trees may be planted at anything from one to ten years old. There are instances of trees having succeeded when more than 10 years old at the time of planting. The older a tree is at the time of planting, the slower it is likely to become established and make satisfactory development. For trees from which poor growth is anticipated, either due to the fact that late planting is done, or that they are more than three years old at the time of planting, the application of a farmyard manure mulch around the base of each tree is advised. This practice is also strongly advised for trees that are planted direct into pasture.

Nitrogen. Other than for the reasons just given in the previous paragraph, or because a nitrogen deficiency is known to exist, the application of nitrogenous fertilizers should be withheld for the first few years. At least they should be withheld until the trees have recovered from the natural check in growth that is the result of the transplanting operation. It is advisable to withhold applications of nitrogen as long as good growth is yielded and the foliage shows no paleness due to nitrogen shortage. Nitrogen should be applied when growth proves to be unsatisfactory, so long as the potash and magnesium status are satisfactory. This stage is normally reached by the time the trees are entering a productive phase, although applications of nitrogen are likely to be required sooner on the drier soils than on deeper loams more retentive of soil moisture. When growth is vigorous and the foliage is a deep green colour, no nitrogen application should be made. When growth is only poor or moderate and the foliage is of a pale green-yellow colour indicating nitrogen shortage, this condition in the first instance is more likely to be apparent in some trees than in others, nitrogen in one form or another should be applied. On deep soils well supplied with moisture, the nitrogen may be supplied as "Nitro-Chalk" or sulphate of ammonia during

March at 1 to 3 cwt. per acre. On soils inclined to become excessively dry early during Summer, nitrogen should be supplied during Winter by a bulky manure such as Shoddy at the rate of about 1 ton per acre.

When " gapping up " (see pp. 243, 260) of an orchard is done, planting direct into grass is sometimes unavoidable, save for a small cultivated part in the immediate neighbourhood of the tree. A nitrogenous fertilizer such as " Nitro-Chalk " should be applied to the cultivated soil during March at the rate of 2 to 4 ounces per square yard each year, except for trees with good vigour. Also a change over from arable to grass management should be followed by applications of " Nitro-Chalk," or the equivalent at the rate of 3 to 5 cwt. per acre, during the late Winter, i.e. January to February. This should normally be done even when trees are vigorous enough at the time of grassing down, and should only be omitted if a disease such as Canker is prevalent (see p. 224), under which circumstance it is advisable to permit a temporary low nitrogen status to occur before making application of a nitrogenous fertilizer (see p. 118).

Potash. During the initial years of development, regular Autumn or Winter applications of sulphate of potash, at the rate of 1 or 2 cwt. per acre, per annum, should be made. The dressing should be increased to an annual dressing of 4 cwt. per acre on soils known to be deficient in potash. The only justification for omitting potash applications at this stage, is when previous generous applications have been made and it is known that the soil is well supplied with available potash.

Phosphate. Applications of a phosphate fertilizer are seldom necessary during the early years. On soils that have low available phosphate, the application at 3 to 5 cwt. per acre of super-phosphate, or the equivalent, during Winter or early Spring is advised.

Magnesium. Applications of magnesium fertilizers for young trees is seldom necessary, except on light, sandy soils and on sites from which old fruit has been cleared, i.e. grubbed, (see p. 64). Under such conditions it is wise, as a precautionary measure, to apply, for two or three years during Winter or early Spring, dressings of magnesium sulphate as Epsom Salts at the rate of 2 to 4 cwt. per acre. In the event of a severe deficiency of magnesium, applications at the 8 cwt. rate should be made for a few years. For soils that are markedly acid, periodical Autumn to Winter applications, say once every 4–8 years, depending on acidity, of Ground Magnesium Limestone should be made, at the rate of 1 ton per acre. Supposing conditions

exist where an initial dressing of Ground Magnesian Limestone would not suffice to correct a magnesium deficiency, supplementary annual applications of magnesium sulphate, at the 4 cwt. rate per acre should be made for a few years.

(ii) Productive Trees.

Differences in variety, vigour and form of management (i.e. whether arable or grass) call for differences in the manurial treatment. The differences are mainly on the nitrogen side and in the employment of bulky organic manures. More vigour and larger fruits are required from non-keeping, early culinary sorts than from the later storage sorts or dessert sorts. A grower must be in a position to decide whether more or less nitrogen is desirable, and to what extent bulky organic manures can be employed to good effect. The main basis of manuring in respect of Potash, Phosphate and Magnesium, which are dealt with under this heading, should be essentially the same for all varieties, except that dessert sorts are likely to benefit from a higher level of potash manuring than culinary sorts, and a higher level of phosphate for storage varieties. The requirements in respect of nitrogen and bulky manures is dealt with under separate management and varietal headings.

Potash. Autumn applications should be at the rate of 4 cwt. per acre, per annum of sulphate or muriate of potash under deficiency conditions and 1 to 2 cwt. per acre, under normal conditions. Applications may be withheld so long as readily available potash is in good supply.

Phosphate. Autumn to Spring applications should be made once every 2 or 3 years at the rate of 3 to 5 cwt. per acre as super-phosphate or the equivalent. This may be omitted when phosphate is supplied together with a nitrogen containing manure such as Meat and Bone Meal. Annual applications should be made when available phosphate is known to be low, and for as long as such a condition persists.

Magnesium. Autumn or late Winter applications of magnesium sulphate as Epsom Salts, to be made every 3 to 4 years at the rate of 2 to 4 cwt. per acre. The more frequent and heavier applications are normally required on light, sandy soils. Annual applications at the 8 cwt. rate should be made when pronounced deficiency symptoms are in evidence. Under acid soil conditions, Ground Magnesian Limestone should be applied at the rate of 1 ton per acre in place of magnesium sulphate. Under such conditions, Ground Magnesian Limestone is likely to be more efficacious than magnesium sulphate, although the

latter, in the event of the deficiency symptoms persisting, should be used once the soil acidity is reduced to a slightly acid or neutral state.

(a) Non-Storage Culinary Sorts (e.g. Early Victoria & Grenadier).
(i) Under Arable Management.

Trees conforming to this description should be maintained in a vigorous state of growth, because large fruits are required from them early in the season. In view of this, periodical Autumn to Winter applications of farmyard manure can be employed with good effect, say at the rate of 10 tons per acre every 4 years. Where dung is not available, other bulky organics may be employed (see under Nitrogen below), such as a straw mulch applied during Autumn at about 2 tons per acre every 3 to 4 years. The annual discing or ploughing in of late Summer weeds is a valuable means of safeguarding against a rapid depletion of soil organic matter, and when such fails to provide a good bulk of herbage, an Autumn sowing of a mixture of oats and tares for the purpose of turning in during Winter is advised.

Nitrogen. When it has not been practicable to apply other bulky nitrogen-supplying manures, such as farmyard manure, periodical Autumn to Winter applications of shoddy, at 1 to 2 tons per acre, may be applied with good effect, especially if some increase in vigour is desirable. Annual applications of other nitrogen-supplying fertilizers are usually necessary, and this may take the form of Meat and Bone Meal and "Nitro-Chalk." The "Nitro-Chalk," or an equivalent fertilizer should be applied not later than March at 2 to 3 cwt. per acre and the Meat and Bone Meal should be applied during Winter at from 5 to 10 cwt. per acre. Rape Meal, Castor Meal or Hoof and Horn, or other equivalent manures, may be used in place of Meat and Bone Meal more especially when the phosphate level is satisfactory. Additional nitrogen applications will be needed during March in the form of 5 cwt. "Nitro-Chalk" or 3 cwt. sulphate of ammonia, if a straw mulch has been applied the previous Autumn (see p. 129). Again it must be stressed that applications of nitrogen can only be made with good effect if the position with regard to potash and magnesium are satisfactory.

(ii) Under Grass Management.

Early culinary sorts are not at their best under grass management, because of their tendency, then, to produce fruits that are neither large enough nor green enough.

Nitrogen. Annual applications of "Nitro-Chalk" or the equivalent should be made at the rate of 4 to 6 cwt. per acre, and it should be applied as a single dressing during January to February. Applications made later than this are likely to affect the growth of the grass more than that of the trees, and for this reason some favour the use of nitrate of soda in preference to "Nitro-Chalk." Nevertheless, during mild Winters, it is difficult to avoid considerable invigorating effect upon the grass whatever the form of nitrogen employed, and success of the treatment is dependent upon the maintenance of a short herbage during the Spring and early Summer months (see pp. 116–118). In addition to the inorganic nitrogen, an Autumn to Winter application of 10 to 15 cwt. of Meat and Bone Meal should be applied.

(b) Storage Culinary Sorts.

(i) Under Arable Management.

Although it is necessary to maintain a high level of nitrogen for sorts under this heading, it should not be done at the expense of storage quality. It is seldom necessary to apply farmyard manure or shoddy, except under shallow and droughty soil conditions, when periodical applications are valuable at the rate advised for early culinary sorts, i.e. 10 tons of farmyard manure per acre or 1 to 2 tons Shoddy at 4 yearly intervals. The discing or ploughing in of late Summer weeds or an Autumn grown cover crop, as a routine, is valuable, as is also the application of a straw mulch at 2 tons per acre every 2 to 4 years.

Nitrogen. An annual application of "Nitro-Chalk" at 1 to 3 cwt. per acre is advised; it should be applied during March, so should an Autumn–Winter application of Meat and Bone Meal, or Castor Meal, at 5 to 10 cwt. per acre. These rates should be reduced or omitted when growth is more vigorous than is wanted, alternatively they can be increased when growth is not up to requirements as the result of a low nitrogen condition. Extra nitrogen will be needed when straw mulches are used, applied as "Nitro-Chalk" or sulphate of ammonia during March at the rate of 4 or 3 cwt. per acre, respectively, in addition to that normally used.

(ii) Under Grass Management.

Under conditions of good soil depth, of the medium–heavy type retentive of moisture, grass orcharding has many advantages over arable management for late keeping culinary sorts. Fruits

of good storage quality are usually produced from such orchards. Seldom is there need to apply bulky organic manures, and should such a position arise, it would be preferable temporarily to convert to arable management.

Nitrogen. For trees of moderate vigour, annual applications of " Nitro-Chalk " at the rate of 3 to 5 cwt. per acre during January to February should be made. Late applications of inorganic nitrogen that will result in an excessive growth of grass should be avoided (see p. 139). Autumn to Winter applications of Meat and Bone Meal at 5 to 10 cwt. per acre should be made.

Dessert Apples.

Certain quality features are highly desirable for the most widely planted dessert sorts, features such as good colour, bright skin finish, firm texture and moderate, rather than large, size. These are more likely to be obtained under conditions that yield medium vigour than under conditions where the growth is very vigorous. Although farmyard manure, at about 10 tons per acre every 3 to 4 years, can be used with good effect on droughty soils, heavy nitrogenous manuring, especially of the bulky organic forms, is usually associated with large poor quality fruit and excessive vigour. Furthermore, excessive nitrogen manuring increases the susceptibility of most dessert sorts to such diseases as Apple Canker and Apple Scab (see pp. 220, 224). Nevertheless there are pronounced varietal differences; from Cox's Orange Pippin, Laxton's Superb and Laxton's Fortune the juiciest aromatics are required; these demand more nitrogen than is the case with Worcester Pearmain, Lord Lambourne and some others.

(a) Under Arable Management.

So long as very vigorous growth is made, nitrogen should be omitted. Under conditions of poor to medium vigour nitrogen should be applied for most varieties, especially when potash and magnesium are in good supply and the foliage has a degree of paleness indicating nitrogen deficiency. Varieties like Worcester Pearmain, James Grieve, Ribston Pippin, Lord Lambourne and Sunset can easily be given too much nitrogen under arable conditions. So long as the foliage is a good green colour and good growth is made, nitrogen should be withheld. Apply nitrogen to these varieties at the rate of 1 to 2 cwt. " Nitro-Chalk " per acre, during March, if the average length of the leading branch shoots is less than 1 foot long and foliage is inclined to be pale in colour (see p. 124). Under conditions

where soil is inclined to be dry, Meat and Bone Meal may be applied, during Winter, at about 5 to 10 cwt. per acre. More bulky manures than this may be used periodically where drought effects would otherwise show, nevertheless the straw mulch type is to be preferred to highly nitrogenous manures. Varieties such as Cox's Orange Pippin, Laxton's Superb and Laxton's Fortune benefit from application of nitrogen, even when growth is moderate. Application of " Nitro-Chalk " at 2 to 3 cwt. per acre should be made during March. Periodical, say once every 3 or 4 years, straw mulching at 2 tons per acre is advantageous, especially on soils inclined to dry out rapidly during Summer. A mulch of this description should be applied during Autumn and " Nitro-Chalk " or sulphate of ammonia should be applied during early Spring at 4 or 3 cwt. per acre, respectively, to safeguard against nitrogen deficiency, pending the rotting down of the straw (see p. 129). In the event of excessive vigour persisting, in spite of the omission of nitrogen, application to grass management is advised. This decision is more likely to be arrived at sooner for close planted Cordons and Dwarf Pyramids, where a lower vigour range is wanted, than for wider planted bush trees. In any case, a lower standard of nitrogenous manuring should be adopted for very close planted trees than for wider ones of comparable vigour.

(b) Under Grass Management.

The change over from arable to grass management is likely to cause a severe check in the vigour of trees subjected to the treatment, especially during the first two or three years, when a pronounced nitrogen deficiency may be apparent. Unless vigour has been markedly excessive prior to the application to grass, or the trees have been subject to the Apple Canker disease (p. 224), 3 to 5 cwt. per acre of " Nitro-Chalk " should be applied during January or February; the sowing to grass having been carried out during the previous Autumn or Spring.

Under all other conditions than those in which the crop is subject to drought, a variety like Worcester Pearmain is best suited to grass management and, provided growth is not excessive, the regular application of " Nitro-Chalk," or its equivalent, at 2 to 5 cwt. per acre should be made during January or February. This applies also to Lord Lambourne, Ribston Pippin, James Grieve and Sunset. If anything, rather more vigour is required from these sorts than from Worcester. The heavier dressing of nitrogen will be made to the least vigorous trees, if the lack of vigour is attributable to shortage of nitrogen.

Varieties like Cox's Orange Pippin, Laxton's Superb and Laxton's Fortune should be maintained in a more vigorous state than Worcester Pearmain, and therefore grass management for these varieties is generally of a more temporary nature. At least under conditions of low rainfall, an application of nitrogen alone may not suffice to restore the required vigour. Growers should not wait until trees are undervigorous before returning them to arable management. The average length of the leading branch-forming shoots required by the grower in these varieties is about 1½ feet and, except for trees more vigorous than this, heavier applications of nitrogenous fertilizers should be applied than for Worcester Pearmain, say Meat and Bone Meal, 5 to 10 cwt. per acre, or Hoof and Horn 3 to 5 cwt., or 10 to 20 cwt. Rape Meal, applied during Autumn to Winter with 2 to 3 cwt. of " Nitro-Chalk " in addition during February.

In order to obtain appropriate benefits from the manures and fertilizers applied, it is necessary to keep the grass tightly mown or grazed during the Spring and early Summer months. When a return to clean cultivation is decided upon, care should be taken to avoid an excess of nitrogen effect. Nitrogen should only be applied when the grass consists of much hay-like material (see p. 247), this, at times, may be the equivalent of an application of straw.

SUMMARY OF TREATMENT.

Sulphate of Potash at 1 to 2 cwt. per acre at 4 cwt. per acre, under deficiency conditions.

Superphosphate at 3 to 5 cwt. per acre every 2 to 3 years. Omit when phosphate is supplied with other manures.

Magnesium Sulphate (as Epsom Salts) at 2 to 4 cwt. per acre every 3 or 4 years, 8 cwt. per acre under deficiency conditions. Use this substance on alkaline soils.

Ground Magnesian Limestone at 1 ton per acre on acid soils which register magnesium deficiency.

Farmyard Manure as a mulch, for trees more than 3 years old at planting, and for trees planted in pasture and around " gapped up " trees. Apply at the rate of 10 tons per acre every four years for early culinary sorts, also for late culinary sorts and dessert sorts on soils inclined to drought.

Shoddy at 1 to 2 tons per acre, to be used in place of dung, where dung is not available.

Straw as mulch, at 2 tons per acre every 2 to 4 years under arable management when other bulky organic manures have not been applied, and under conditions subject to drought effects.

"*Nitro-Chalk*" *or Sulphate of Ammonia* at 1 to 3 cwt. per acre for young trees indicating nitrogenous shortage; at 3 to 5 cwt. per acre during February after applying to grass; at 2 to 4 oz. per square yard round gapped-up trees; at 2 to 3 cwt. per acre for productive early culinary sorts under arable conditions; at 4 to 6 cwt. per acre for productive early culinary sorts under grass management; at 1 to 3 cwt. per acre for productive late culinary sorts under arable conditions; at 3 to 5 cwt. per acre for productive late culinary sorts under grass management; at 1 to 2 cwt. per acre for productive Worcesters and other similar dessert types under arable conditions, when growth is poor and foliage is pale, indicating low nitrogen; at 2 to 3 cwt. per acre for productive Cox and similar types under arable conditions where growth is moderate; at 2 to 5 cwt. per acre for productive Worcester and Cox types under grass management except for vigorous trees. When "Nitro-Chalk" is chosen a heavier application should be made than when sulphate of ammonia is chosen.

Meat and Bone Meal at 5 to 10 cwt. per acre for all productive culinary sorts, except early culinary sorts under grass, for which application should be increased to 10 to 15 cwt. per acre; at 5 to 10 cwt. per acre for productive dessert sorts under dryish arable conditions; at 5 to 10 cwt. for productive Cox type making moderate to good growth under grass management.

Hoof and Horn. Rape Meal. These and other nitrogenous fertilizers should be employed at appropriate rates, in place of Meat and Bone Meal, when phosphate status is satisfactory. Care should be taken to guard against potash and magnesium deficiencies if the maximum benefits are to be obtained from nitrogenous manuring.

2. Pears, Plums and Damsons.

In general, the requirements of pears, plums and damsons may be said to approach that of soft fruits and of the early culinary apple, rather than that of the dessert apple. Most varieties of the three fruits under consideration should be maintained in a fairly vigorous state of growth, because large fruits are required from them; this especially applies to pears and plums. Similar considerations to those for apples apply here in respect of potash, phosphate and magnesium. Although it is true that there are certain sorts of pears that succeed under conditions of lower potash than would be needed for apples,

the widely-grown pear variety, Conference, is markedly susceptible to potash deficiency. Nevertheless, a higher nitrogen-potash ratio should be maintained for pears and plums than for dessert apples. For soil applications of potash, phosphate and magnesium, see pp. 135–138.

Pears and Damsons seldom make as much young growth in the season following planting as might be desired. In view of this, a mulch of farmyard manure, at the base of the trees, at the time of planting, is of great value. Plums can normally be depended upon to make satisfactory growth without a mulch, if the planting conditions are reasonably fertile. Sites that have previously been poorly farmed and are in a low state of fertility, benefit greatly from pre-planting applications of bulky manures, such as farmyard manure at 20–30 tons per acre, or feathers at 2 tons per acre or Shoddy at 2 tons per acre. Also the growing of a cover-crop for ploughing or discing in, prior to planting, is beneficial. No pre-planting application of organic manures is needed for soils that are in a high state of fertility.

(i) Young Trees.

The preliminary mulching with farmyard manure should suffice for two or three years so far as nitrogenous applications are concerned. Manuring need not be done so long as vigorous growth with healthy green leaves is maintained. When growth is only moderate, and more vigour is desired, " Nitro-Chalk " or sulphate of ammonia should be applied at 1 to 2 cwt. per acre during February, with the addition of an Autumn application of 3 to 5 cwt. Meat and Bone Meal. This recommendation is made on the assumption that the potash and magnesium status is satisfactory. Periodical Autumn to Winter applications, say once every four years, of farmyard manure at 10 to 20 tons per acre, or feathers at 1 to 2 tons per acre, or shoddy at 1 to 2 tons per acre, should be provided, especially when young growth is less than good. Alternatively, a straw mulch applied during Autumn at 2 tons per acre with the addition of 5 cwt. sulphate of ammonia during February could be provided. For potash, phosphate and magnesium applications see pp. 135–137.

(ii) Productive Trees.

Periodical applications of bulky organic manures are advisable, because pears and plums are usually at their best on cool soils which afford good moisture-holding properties. When very vigorous growth is maintained and there is poor cropping because of excessive vigour, nitrogenous manuring

should be withheld. Under conditions of moderate vigour, or less than moderate, the bulky organic manures should be supplied just as has been recommended for young trees, viz., periodical farmyard manure at 10 to 20 tons per acre, or feathers or Shoddy at 1 to 2 tons per acre, or straw at 2 tons per acre with the addition of 5 cwt. of sulphate of ammonia. In addition to this, more frequent applications, say every alternate year, of manures such as Hoof and Horn at 4 to 5 cwt. per acre or Meat and Bone Meal at 5 to 10 cwt. per acre, or Rape Meal at 15 to 20 cwt. per acre should be made during Autumn or early Winter.

Regular applications of inorganic nitrogen are advised for productive trees, so long as they do not tend to the over-vigorous state. The rate suggested is 1 to 2 cwt. of "Nitro-Chalk" or sulphate of ammonia per acre during February to March, followed by a further 1 cwt. per acre of "Nitro-Chalk" during May, in the event of a heavy fruit set. Applications should be omitted for trees that while making vigorous growth, are not producing satisfactory crops.

SUMMARY OF TREATMENT.

Sulphate of Potash at 1 to 2 cwt. per acre, at 4 cwt. per acre under deficiency conditions.

Superphosphate at 3 to 5 cwt. per acre every 2 or 3 years. Omit when phosphate is supplied with other manures.

Magnesium Sulphate (as Epsom Salts) at 2 to 4 cwt. per acre every 3 or 4 years, at 8 cwt. per acre under deficiency conditions. This substance should be used on alkaline soils.

Ground Magnesian Limestone at 1 ton per acre on those acid soils which register a magnesium deficiency.

Farmyard Manure, as a mulch round trees, at the time of planting, or at 20 to 30 tons per acre before planting, for soils in low state of fertility. At 10 to 20 tons per acre every 3 or 4 years if trees are not too vigorous.

Shoddy. Feathers. As alternatives to farmyard manure applied at 1 to 2 tons per acre.

Straw at 2 tons per acre as an alternative to farmyard manure.

Meat and Bone Meal at 3 to 5 cwt. per acre for young trees requiring more vigour. At 5 to 10 cwt. per acre for productive trees, every alternate year, except when too vigorous.

Hoof and Horn as an alternative to Meat and Bone Meal at 4 to 6 cwt. per acre, when phosphate is in good supply.

Rape Meal as an alternative to Meat and Bone Meal or Hoof and Horn at 15 to 20 cwt. per acre.

Sulphate of Ammonia at 5 cwt. per acre if straw has been applied. At 1 to 2 cwt. per acre for young trees requiring more vigour. At 1 to 2 cwt. during February and March, for productive trees.

" *Nitro-Chalk* " as an alternative for sulphate of ammonia. Also at 1 cwt. per acre in May, during years of heavy crop.

3. Cherries.

Young cherries require arable conditions and a fertile soil, if they are to become sizeable trees in a reasonable space of time. Deficiency problems are more likely to occur in the young tree, whilst all the roots are near to the soil surface, and they are less likely to occur in the moderate sized or large mature trees grown under soil conditions which provide adequate depth and the necessary physical conditions (see p. 38).

Cherries are usually interplanted with other tree fruits such as plums, although certain disadvantages of doing this on account of Bacterial Canker and application to grass have already been mentioned (p. 63). Nevertheless, the management advised for young plums is suited to cherries, and similar manurial treatment should be given (see p. 144). Whilst it is a satisfactory feature to obtain vigorous growth from the young cherry trees, very vigorous growth of the sappy, succulent type should not be fostered, because there may be increased susceptibility to both " Gumosis " (i.e. the oozing of gum from the branches) and to the Bacterial Canker disease (see p. 239). In view of this, heavy applications of inorganic nitrogen should be omitted so long as good growth is being made.

When cherries are anything from 8 to 12 years old, it is the usual practice to change over from arable conditions to grass management. A severe check in the vigour is likely to be sustained during one or two growing seasons, after the treatment, unless applications of a readily available nitrogen are made. During the first two years after application to grass, " Nitro-Chalk " or sulphate of ammonia should be applied during January to February, at the rate of 5 to 6 cwt. per acre; after this, if vigour is good, the application may be reduced to the 3 to 4 cwt. rate. The heavier application will be made when " Nitro-Chalk " is chosen.

With mature trees, a steady moderate growth is favoured, rather than a vigorous state or one of fluctuating extremes;

moderate growth renders the fruit less liable to split when ripe or nearly so (see p. 39), after rain.

Potash. This fruit is less subject to potash deficiency than most of the other fruits with which we have dealt. The marginal scorch, characteristic of potash deficiency, will show readily on young trees, but in the case of older trees, a general stunting of growth and an upfolding of leaves will be apparent before leaf scorch symptoms appear. Under deficiency conditions, applications at the rate of 4 cwt. of sulphate or muriate of potash should be made during Autumn until a correction of deficiency symptoms is achieved. Under normal conditions, applications of either sulphate or muriate of potash should be made, once every 2 or 3 years at the rate of 2 to 3 cwt. per acre.

Phosphate. The equivalent of 3 to 5 cwt. per acre of superphosphate should be applied during Autumn to early Spring of most years, especially where a quality herbage is required for grazing purposes, and where phosphate is not supplied in other manures. Basic slag at 6 cwt. per acre may be used occasionally in place of the superphosphate, especially under acid conditions.

Magnesium. It is rare to see symptoms of magnesium deficiency in fully established cherries, although it often occurs in young trees with which it is frequently a limiting factor, prejudicing the rapid establishment of trees. Growers would do well to make periodical, say once in four years, applications of magnesium sulphate (as Epsom Salts) at the rate of 4 cwt. per acre during Winter to early Spring. Under deficiency conditions, and so long as they persist, annual applications should be made at the 8 cwt. rate. Under acid conditions, periodical Autumn applications of Ground Magnesian Limestone at 1 ton per acre should be made.

Nitrogen. Although a periodical application of dung at 20 to 30 loads per acre, is of great value in practice, it is seldom spared for this crop. Annual Autumn to Winter applications of the less bulky organic manures, which give a slow discharge of nitrogen should be made, this can be done in the form of Meat and Bone Meal at 10 to 20 cwt. per acre or Feather Waste, 15 to 30 cwt. per acre, or Castor Meal at 20 to 40 cwt. per acre. When increased vigour is needed, applications of "Nitro-Chalk" at 6 cwt. per acre, should be made during February.

For old trees, increased manuring may not suffice to produce a restoration of vigour, in which case a temporary return to arable management should be favoured. If the grass is short at the time of bringing to arable conditions, no nitrogenous applications need be made. If it is tall, and strandy, 4 to 5

cwt. of "Nitro-Chalk" or sulphate of ammonia should be applied immediately prior to the cultivation. For the first two or three years after bringing to arable, no nitrogen manuring is likely to be needed, but after this, a return to the normal nitrogen applications should be made.

SUMMARY OF TREATMENT.

Sulphate of Potash at 4 cwt. per acre, under deficiency conditions; at 2 to 3 cwt. per acre every 2 or 3 years under normal conditions.

Superphosphate at 3 to 5 cwt. per acre when phosphate is not supplied in other fertilizers.

Basic Slag at 6 cwt. per acre under grass conditions when soil type is acid, in place of superphosphate or other phosphatic ferilizers.

Magnesium Sulphate (as Epsom Salts) at 8 cwt. per acre before planting, and annually, so long as deficiency conditions persist. Under normal conditions, apply 4 cwt. per acre, once every 4 years.

Ground Magnesian Limestone at 1 ton per acre, under acid conditions, when magnesium deficiency is apparent, This should be applied, say once every six years, in place of magnesium sulphate.

Farmyard Manure at 20 to 30 loads per acre once every 6 years after application to grass.

Meat and Bone Meal at 10 to 20 cwt. per acre. Omit if farmyard manure is applied.

Feather Waste at 15 to 30 cwt. per acre as alternative to Meat and Bone Meal.

Castor Meal at 20 to 40 cwt. per acre as alternative to Meat and Bone Meal or Feather Waste.

"*Nitro-Chalk*" at 1 to 2 cwt. per acre for young trees under arable conditions, showing need for nitrogen, at 3 to 4 cwt. under grass conditions. Apply 5 to 6 cwt. under deficiency conditions, and for the first two seasons of application to grass.

Sulphate of Ammonia may be used as an alternative to "Nitro-Chalk."

CHAPTER VII

PRUNING

In order to facilitate the effective development of all woody fruit crops and in order to maintain a high level of productive efficiency pruning is necessary. We begin with the Cane Fruits which have only simple pruning requirements and from these we proceed to Bush Fruits and Tree Fruits. As the story of pruning develops, Summer pruning, Deferred Winter pruning, Ring pruning and corrective measures against Biennial Bearing are described.

When a site is applied to fruit, it is done on the assumption that it will be occupied by such for several years. The only exception to this general ruling is strawberries which seldom yield more than four crops. Strawberries, unlike other fruits, neither grow tall nor produce woody stems. It need hardly be pointed out that trees and bushes of the woody-stemmed fruits are required, in their growth, to occupy the space allocated to them to the best advantage. If they did this of their own accord, there would not be much need for pruning. It is a function of pruning to get rid of encumbering and valueless material such as dead wood. Since unwanted shoots can be removed by pruning, and since shoots are stimulated to grow by pruning, it is an invaluable means of securing the production of shoots and the development of branches where they are most wanted. By an appropriate selection of shoots that possess structural or productive qualities required, pruning can be used to ensure sufficient space for them and so to regulate their development that they have favourable conditions to fulfil the purpose for which they were selected. It is known that there is a limit to the number of canes, shoots or branches that can occupy a given space for the purpose of maintaining productive crops. When a greater number than this is retained, reduced cropping may result from deficiency of light; or stated another way, it is due to the shading effect of cane shoots or branches upon one

another. Pruning is a safeguard against such a condition. Also, by pruning, quantity and quality of a crop are affected. By reducing the potential productive channels, fewer fruits are borne, but their average size is increased. Furthermore, once the various kinds of tree fruits have arrived at the productive stage, much can be done by pruning to prevent a decline in productivity and to maintain good crops.

This may be a convenient stage at which to summarize the main reasons for pruning (before we proceed to give a rather more detailed description of the pruning treatments required by the various fruits). The main reasons for pruning are:—

(i) To aid the production of shoots and the development of branches where they are most needed.

(ii) To select and retain material best fitted to serve in various capacities, viz. (*a*) as branches, (*b*) as current productive material, (*c*) as future productive material.

(iii) To remove material that would otherwise impair efficiency of the material retained (see (ii) above).

(iv) To regulate the quality and quantity of fruit borne.

(v) To secure, so far as is practicable, regular crops.

Obviously the reasons for pruning are closely bound up with the effects of pruning. Pruning is not only concerned with assessing what material should be eliminated for the benefit of what is retained, but it is also concerned with the effect it has upon the tree or bush as a whole and upon the vigour that will be gained as a result of the treatment. It may be pointed out, that the immediate result of any pruning is to reduce the surface of what is pruned. Usually this reduction is only applied to the parts above the soil, leaving trees, bushes and canes smaller than they were before. It leaves the roots as they were, and so there is a relative increase of the root-shoot ratio. The effect of this, when done during the dormant season, is to increase the stimulation for the production of shoots the next growing season; so increased material becomes available as potential productive surface. Although on balance a gain can be obtained, the temporary reduction in size that is necessary to achieve it, means that less material is available for immediate productive purposes. For trees that are growing strongly this means that, for a time, lower crops will be borne. The paradox of pruning is that a gain can seldom be achieved without some loss. The aim is to secure the greatest practicable gain for as little loss as possible.

In pruning one should always try to avoid the death of wood immediately below the point of pruning, so the operator should

cut as close above buds as is practicable without causing them injury. Branches should be removed close to a neighbouring branch so that no " snag " of wood is left to die.

1. THE PRUNING OF CANE FRUITS.

RASPBERRIES, LOGANBERRIES, BLACKBERRIES.

These fruits are dealt with first because their pruning requirements are the simplest to understand.

Treatment During Season of Planting.

In order to secure a rapid establishment of newly planted canes, the best practice is always to cut them down to within a few inches of soil level during the early Spring of the season of planting. There is something to be said for leaving the canes unpruned so that they yield leaves, for this assists root development. Unfortunately, any possible advantage of such a practice is offset by the fact that it is prejudicial to the rapid establishment of these fruits to allow them to blossom and fruit during the season immediately after planting. Leaves are an advantage, but crop is a disadvantage. In view of this, the top and centre portion of each cane, amounting to about two-thirds in all, should be removed by cutting to a live bud and leaving the basal 6–18 inches of each cane. Some blossoms and fruits will be borne from buds on the canes but good leaves also are generally borne and as a rule, basal buds are not the most productive.

Subsequent Treatment.

Readers will have gathered already that all three crops under consideration bear most of their fruit and all of it, in the case of the loganberry, on canes that have grown the previous year. It is usual for the canes of these crops, with the possible exception of blackberries, to die soon after they have fruited. These old fruiting canes, for the most part dead ones, should be removed, during Autumn, as soon after cropping as practicable. They should be severed from the parent plants at positions as near to the soil level as possible. In addition to the removal of dead wood, the small and weak growing canes, as compared with those of average length should also be removed.

For blackberries and loganberries, it is seldom necessary to remove any more canes than already indicated. Raspberries frequently yield more canes than are beneficial for the production of satisfactory crops. The number of raspberry canes that should be retained for crop production should seldom exceed

six per foot of row. All canes in excess of this number should be cut out to leave those that remain as evenly spaced as possible.

During early Spring, further pruning is needed for all these kinds of fruits and consists of a shortening of the new fruiting canes. The buds and wood at the extreme tips of canes are seldom as hardy or mature as those lower down. In point of fact, it is the middle portion of the canes that is looked to for the bulk of the crop and as the extreme tops are subject to Winter injury, they often die. Up to one-third of each fruiting cane should be removed, although it is seldom necessary to remove as much as this. The amount to be removed is governed by the quantity of dead wood there is and how long the canes are. While short canes may only need the removal of the tips, from longer ones more will normally need to be removed.

SUMMARY OF TREATMENT.

(i) During Early Spring Following Planting.
Cut back canes to a live bud, leaving them 6–18 inches long.

(ii) Routine Treatment.
(*a*) Remove old canes after fruiting, say during Autumn or Winter.
(*b*) Remove weak canes and, in the case of raspberries, space to leave no more than six per foot length of row.
(*c*) Remove tips of new season's fruiting canes during early Spring.

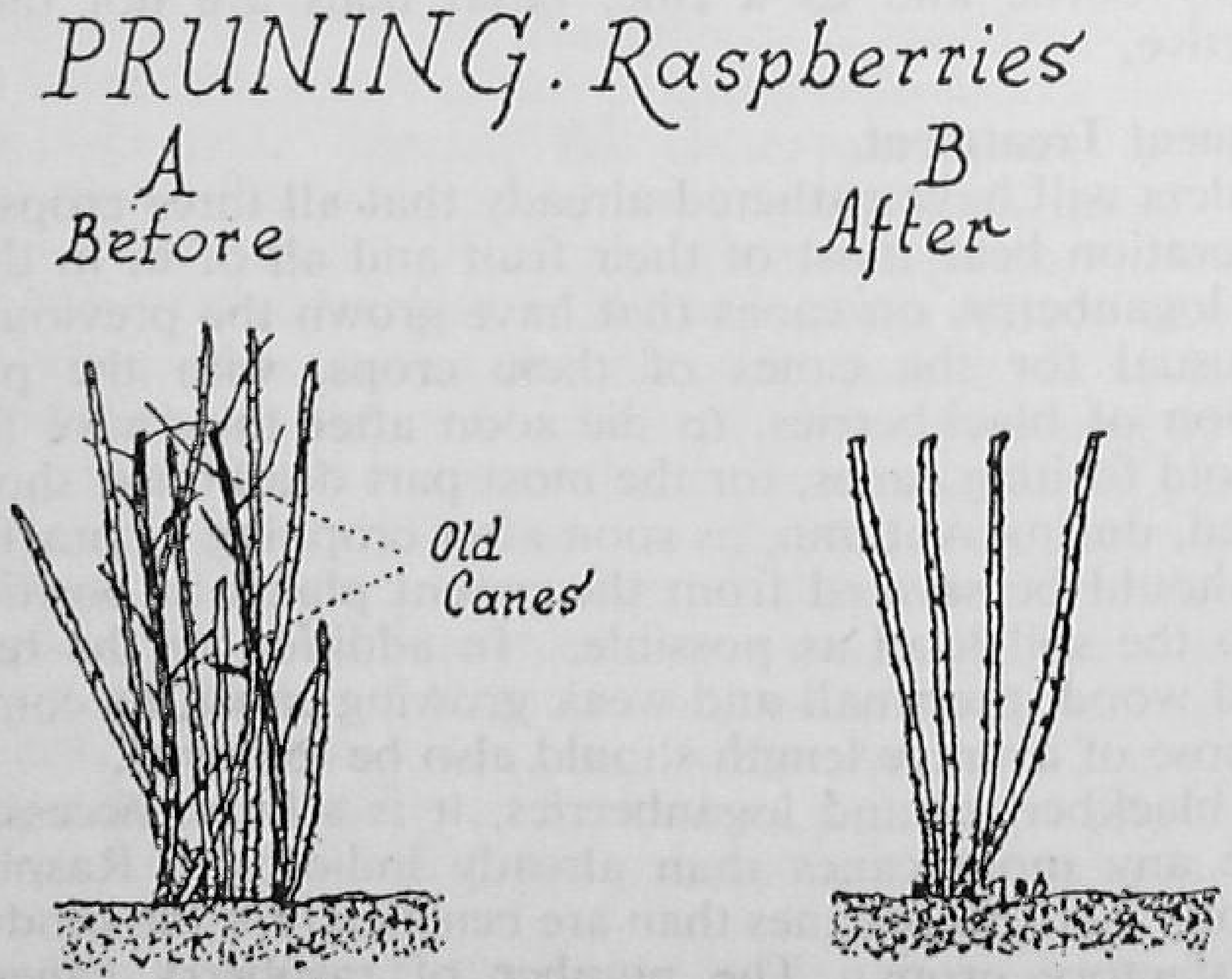

Fig. 9

2. THE PRUNING OF BUSH FRUITS.

BLACKCURRANTS.

The pruning treatment of this fruit is based on the requirement of a plentiful supply of young shoots each season for productive purposes and upon the fact that when wood is more than two years old, its production power declines with increasing age.

A young bush is required to grow vigorously so that no time shall be lost in its attaining full size. The habit of the blackcurrant is to bear most of its fruit on young growth formed during the previous season.

The Newly Planted Bush.

Following upon the check sustained at transplanting, the young shoots of a newly planted bush are hardly fitted to bear fruit, either in quantity or quality, that would justify harvesting. Furthermore, bearing would, to some extent, prevent the formation of young shoots needed for the early establishment of the bush. In view of this, all the shoots of a newly planted bush should be cut down, leaving only one or two buds of each visible above soil level. In the event of late planting during Spring, it is better to defer this treatment until the following year. Supposing poor growth is made after the treatment, so that not more than a few short shoots are formed, the same treatment should be repeated for a second season.

The Young Established Bush.

Once good shoots, 18 inches or more in length are being formed, most of them should be retained each season, but some of them should be cut back as before to ensure a regular supply of young growth from the base of each bush. Since at this stage none of the shoots are more than one year old, about one third of the total number formed by each bush should be removed, the poorest being chosen. By the next pruning season, there will be some one year, or new season's growth, and some two year wood in the bush. Some of the new season's growth will have been formed at the base of the bush and some as side growths and extensional growths of the two year wood. It is the two year wood that normally gives rise to most of the young shoots and these produce most. These two year branches together with their young shoots should generally be retained, but any two year growth very deficient in young shoots, or held too near to the soil or in the way of cultivation, should be removed completely as near the soil level as practicable. As

for the new season's shoots arising directly from the base of the bush, they should be dealt with as for the previous season, that is one-third of their number should be removed.

The Fully Established Bush.

Once there is three year old wood in a bush, which in its turn carries both two year and new season's material, it is evident that these parts are becoming unproductive and these unproductive parts may, or may not, exceed the amount of young productive wood. When this stage is reached, the pruning should consist principally in removing the oldest branches that have on them the least young wood, and the point of severance from the bush should be as near soil level as practicable. The branches that lie almost flat, in the way of cultivators or too near to the soil, and weak shoots less than 1 foot long, at the base of a bush, should also be removed.

A guide as to the proportion of a bush to be removed annually to maintain it in the required state of juvenility, is the fact that no wood more than four years old is wanted. Thus one-quarter to one-third of the total wood of a bush, choosing the oldest branches, should be removed each Winter. If this principle is adhered to, it is unnecessary to prune with the idea of producing shapely bushes because every branch becomes due for removal with the lapse of years. Furthermore, by following a system whereby none of the branches are retained for more than a few years, and all are replaced by younger ones, the problem of excessive shade does not arise. Stated briefly, the method described is one of continuous replacement or renewal for the purpose of a long term productive maintenance.

SUMMARY OF TREATMENT.

(i) **The Newly Planted Bush.**

Remove all shoots to leave one or two buds visible above soil level. Repeat the next year if good growth has not been made.

(ii) **The Young Established Bush.**

(*a*) Remove one-third in number of the new season's shoots at soil level, choosing the poorest shoots for removal.

(iii) **The Fully Established Bush.**

Remove at soil level about one-quarter to one-third of the total surface of a bush, choosing for the purpose:—

(*a*) Oldest branches with least new season's wood.
(*b*) Branches that lie too near the soil.
(*c*) Weak new season's shoots at the base of a bush.

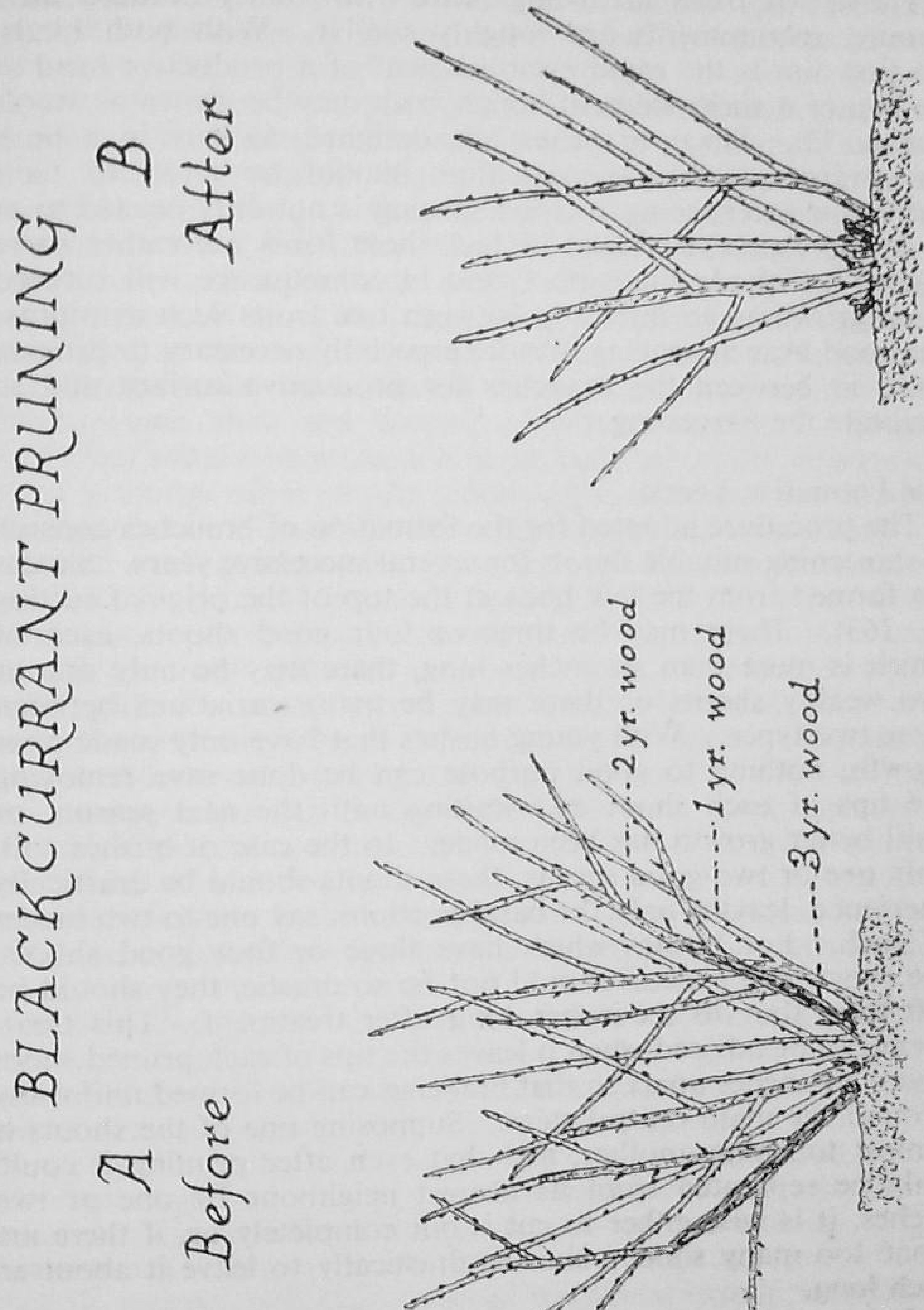
BLACKCURRANT PRUNING
A Before
B After
2 yr. wood
1 yr. wood
3 yr. wood

Fig. 10

GOOSEBERRIES AND REDCURRANTS.

These two fruits are being dealt with jointly because their pruning requirements are roughly similar. With both kinds, the first aim is the rapid establishment of a productive head at the top of a short stem, although both may be grown as stools (see p. 73). Since branches are designed to stay in a bush for several years, some attention should be given to their formation and spacing. Good spacing is not only needed so as to avoid excessive shade, in fact these fruits are rather more tolerant of shade than most, and in consequence will succeed when grown as an intercrop between tree fruits such as plums; but good branch spacing is more especially necessary to provide room in between the branches for productive surface and to facilitate the harvesting.

The Formative Years.

The procedure adopted for the formation of branches consists in shortening suitable shoots for several successive years. Shoots are formed from the few buds at the top of the original cutting (p. 263). There may be three or four good shoots, each of which is more than six inches long, there may be only one or two weakly shoots or there may be many variations between these two types. With young bushes that have only made poor growth, nothing to good purpose can be done save removing the tips of each shoot and waiting until the next season, or until better growth has been made. In the case of bushes with only one or two good shoots, these shoots should be drastically shortened, leaving only the basal portions, say one to two inches of each. For bushes which have three or four good shoots, the shortening process should not be so drastic, they should be left from four to six inches long after treatment. This treatment can be advised when it leaves the tips of each pruned shoot about six inches apart so that branches can be formed uniformly around the main central stem. Supposing one of the shoots is almost touching another, and that even after pruning it could only be separated from its nearest neighbour by one or two inches, it is wise either to cut it out completely or, if there are none too many shoots, shorten drastically to leave it about an inch long.

It is usual for these fruits to make only poor growth during the first year after planting out from the nursery, and when this is the case, only the tips of the new season's growth should be removed. Nevertheless an isolated shoot may have grown with greater vigour than the rest and it will have to be shortened

severely so that it is not out of balance with the rest. When planting is done on sites or under conditions where only poor growth is probable, it is preferable to leave unpruned for the first season and prune, as for a first season's recommendation, a year later when good growth can normally be expected.

Once a bush has become established, each pruned shoot will yield two or more shoots from buds nearest the pruning wound. It is from such shoots that increases in the dimensions of bushes can be gained. While no more than three or four shoots are wanted as the first branches these will yield shoots from which as many as six to eight may be selected to form branches. A condition of their admission as branches, is that there be room for them on the same side of the bush as the parent branch from which they are derived. Shoots designed to become branches should be separated by at least six inches at their tips after pruning. It is usually necessary to remove about one-half to two-thirds of each branch-forming shoot, or as they are termed, leading shoots, at this stage. When the leading shoots are left long for redcurrants, much bareness of wood and a deficiency of branches results. With gooseberries, severe pruning of leading shoots is to be advised, otherwise they bend over with the weight of fruit and then they make little new growth, and they are of little use as branches. All leading shoots should not be pruned to the same height or the majority of young shoots will be formed at the same level, and this is undesirable. Some dispersal of growth is to be preferred, and therefore it is advisable to prune to the same level every alternate leading shoot and the others a few inches shorter, so as to have alternating taller and shorter leading shoots.

The general principle is to select leading shoots if they are available and if there is room for them. In view of the close planting distances of both gooseberries and redcurrants, more than eighteen shoots are seldom required to form branches, and some such number as this should be required by the time a bush has a spread of 3 feet. The leading shoots should be shortened so long as a branch is being formed and is not tall enough. Once a branch is nearly tall enough and no further sub-division of branches is required from it, the leader need not be pruned, although those at low levels should be pruned.

The Productive Years.

Having dealt with the pruning required to form the branches, there remains the consideration of the side growths, or " laterals " as they are frequently termed, Young wood in both

gooseberries and redcurrants is very productive of fruit. Shoots that are formed one year will fruit the next. In the case of gooseberries, a one year old shoot is productive over its entire length; while in the case of redcurrants, a one year old shoot is most productive at each end, the tip and the base, and it bears comparatively little fruit in the central portion where the buds are widely spaced.

The first essential, irrespective of the fruiting propensities of this or that shoot, is to eliminate all crossing and rubbing of one shoot or branch with another; this is especially necessary with gooseberries where ease of picking the fruit is of primary importance. Both for gooseberries and redcurrants, the large majority of new season's side shoots should be shortened every Winter. In the case of gooseberries, large fruits are wanted and since it is more than probable that a lot of small fruits would be borne if all the new season's wood were left to crop, it is wise to reduce the amount of this wood. The larger the fruits are wanted, the more it is necessary to reduce the amount of the young productive wood. With young strong growing gooseberry bushes that have not carried big crops, shoots that are six inches and less in length may be left unpruned, whilst those that are longer than this should be shortened to leave them 3–4 inches long. Strong growing shoots neighbouring the selected leading shoots should be removed altogether to avoid too much new growth being formed at the tips. As the size of a bush increases and the crop-yields goes up, only short shoots less than three inches long should be left unpruned and the remainder should be shortened to leave them 2–3 inches long. After this has been done for a few years, many of the young shoots will be formed at the tips of branched shoots that have been formed as a result of previous prunings. When this stage is reached, some of the oldest multi-branched shoot systems should be completely removed each season, especially those that have little young growth on them and those that cause a general congestion of shoots so as to make for harvesting difficulties.

For redcurrants, a similar procedure should be adopted as for gooseberries, but for this fruit it is mainly with the idea of preventing any considerable surface of bare wood being formed. New season's shoots less than 4 inches long should be left unpruned and the remainder shortened to leave them about 1 inch long. Whilst bushes are growing vigorously and are relatively unproductive as with gooseberries, a greater proportion of the shoots should be left unpruned. Shoots that have been left unpruned should be shortened during the next pruning

season by cutting them back to leave only the cluster of buds at the base of each. For bushes that have failed to make a good supply of young growth, the treatment of side shoots should be the same, but the size of such bushes should be reduced by shortening the branches. This is done by pruning back into 2–3 year old wood.

Not infrequently strong growing shoots are formed at the base of gooseberry and redcurrant bushes; a few of these may be made use of during most years for the purpose of providing new branches, and they should be pruned as already advised for branch forming shoots. These new branches are intended to replace older ones that are beginning to decline in vigour and productiveness. Such older branches should be removed as soon as there are suitable new ones to take their place. A start should be made in forming a few replacement branches as soon as the first formed branches are five or six years old, and not more than two of them should be admitted during any one year unless their introduction has been neglected for a few years. All other strong growing shoots at the base of a bush, especially those formed at soil level, should be pulled clean out rather than cut out. The practice of cutting out such shoots invariably results in more of them being formed by the following year.

The advisability of removing all dead and diseased wood need hardly be stressed. In the case of gooseberries, it is sometimes necessary to remove the tips of all young shoots because they are infected with American Gooseberry Mildew (see p. 214).

SUMMARY OF TREATMENT.

(i) The Formative Years.

(*a*) *Bushes with a Number of Shoots of Good Growth.*
Select three or four young shoots to provide the initial branch framework and remove the rest. Shorten the selected shoots to leave them about 4–6 inches long and approximately 6 inches apart at the tips after pruning.

(*b*) *Bushes with Only One or Two Good Shoots.*
Shorten the young shoots severely to leave only 3–4 buds at the base of each. Treat as (*a*) above once better growth is made.

(*c*) *Bushes with Only Poor Growth.*
Remove only tips of young shoots. Treat as (*a*) above once good growth is made.

(ii) Routine Leader Treatment.

With increasing size of bushes select young shoots to form branches up to a maximum of eighteen. Shorten selected leading shoots by removing about one-half to two-thirds of each, leaving them alternately taller and shorter and the tips about 6 inches apart. Do not tip leaders of branches that are tall enough, except where increased size of fruit is wanted.

After bushes are 5–6 years old, admit one or two new leaders each season from positions near to the base of a bush.

(iii) The Productive Years.

(*a*) *Bushes Making Vigorous Growth.*

Leave unpruned side shoots 6 inches and less in length. Shorten side shoots more than 6 inches in length to leave them 3–4 inches long for gooseberries, and 1 inch long for redcurrants.

(*b*) *Bushes Making Moderate Growth.*

Leave unpruned side shoots less than 3 inches in length. Shorten side shoots 3 inches and more in length to leave them 2–3 inches long for gooseberries and 1 inch long for redcurrants.

(*c*) *Bushes Making Poor Growth.*

Treat side shoots the same as for (*b*). Shorten branches by cutting back into 2–3 year old wood.

(*d*) *General.*

For leader treatment see (ii) above.

Remove branches declining in vigour and productiveness once replacement branches have been formed to take their place. Eliminate dead and diseased wood, also rubbing wood and strong growing shoots at the base of bushes when they are not wanted as leaders. Remove vigorous shoots that are very near to (and competing with) leaders. Remove branched side-shoots that have resulted from the pruning treatment, if they are weakly or if they are likely to impede harvesting.

3. THE PRUNING OF TREE FRUITS.

There is no simple prescription for pruning tree fruits since the procedure will be different with different forms of trees (whether Cordon, Dwarf Pyramid, or Wide planted Trees),

with different stages of development and vigour of the trees, (whether young or mature, vigorous or under-vigorous), with different kinds or varieties, (whether culinary or dessert and whether apples, pears, plums, damsons or cherries).

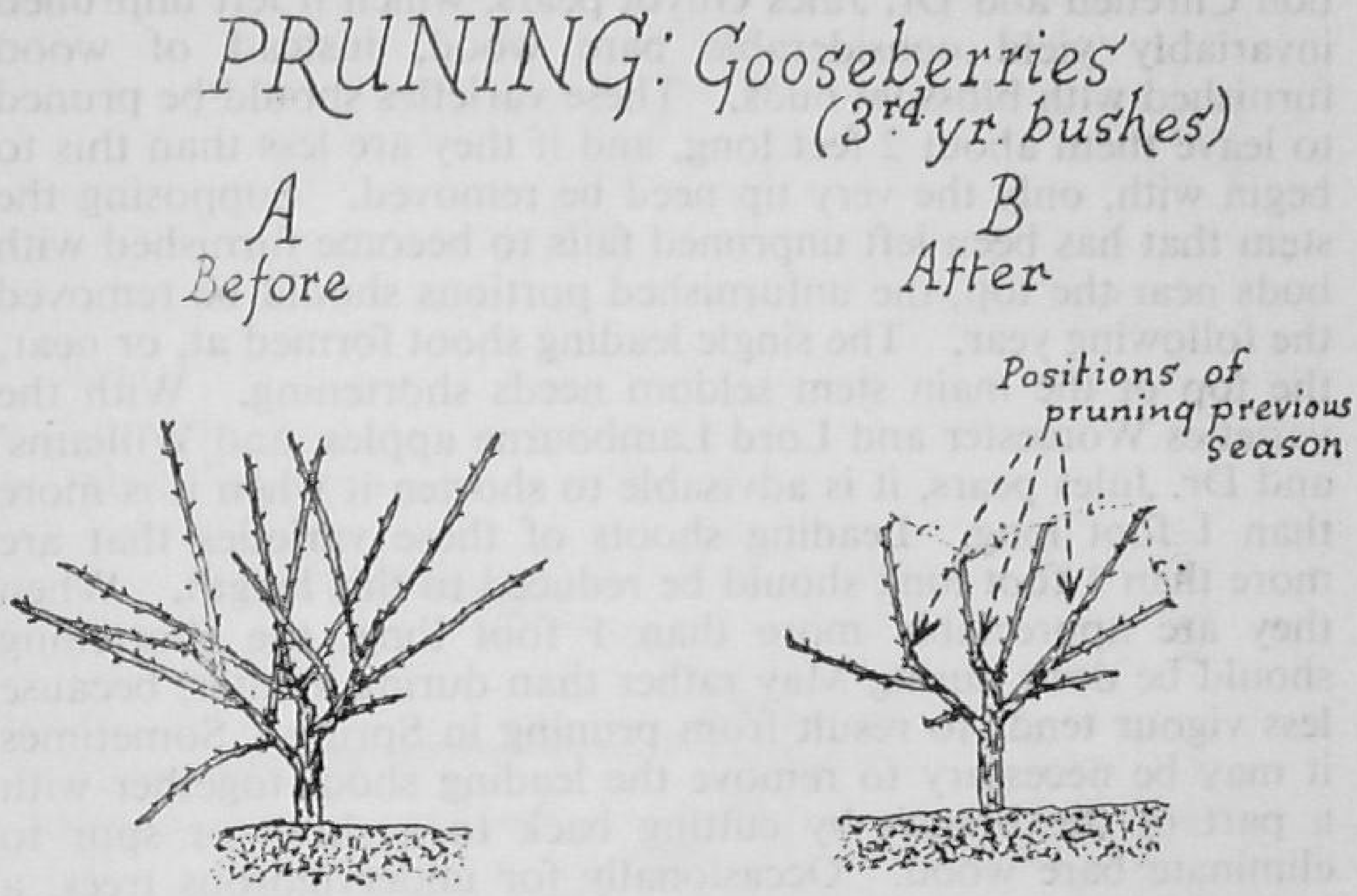

Fig. 11

Commercially, only apples and pears are acceptable as Cordons and Dwarf Pyramids and even with these the choice among apples is limited to a few varieties, which (either by their nature or as a result of the rootstock upon which they are worked) will only form small trees of less than moderate vigour. As a rule only dessert varieties will be chosen for very close planting, with certain possible exceptions (see pp. 157, 84). Often with Cordon and Dwarf Pyramid trees as a result of excessive vigour, there arises a pruning problem which need not have occurred if a judicious choice of variety, rootstock and soil had been made.

APPLES AND PEARS (close planting systems).

(a) CORDONS.

This is the simplest form of tree, because the commercial Cordon usually consists of a single branch with its surface clothed with young shoots, spurs (i.e. short shoots that are terminated by a blossom bud or buds forming a rosette of leaves) and stubs (i.e. shoots that have been shortened by pruning).

The Leading Branch.

Starting with the single stemmed one-year-old tree, no pruning is needed during the first year, except for varieties such as Worcester Pearmain and Lord Lambourne apples, William's bon Chrétien and Dr. Jules Guyot pears, which if left unpruned invariably yield considerable bare wood, instead of wood furnished with blossom buds. These varieties should be pruned to leave them about 2 feet long, and if they are less than this to begin with, only the very tip need be removed. Supposing the stem that has been left unpruned fails to become furnished with buds near the top, the unfurnished portions should be removed the following year. The single leading shoot formed at, or near, the top of the main stem seldom needs shortening. With the varieties Worcester and Lord Lambourne apples, and Williams' and Dr. Jules pears, it is advisable to shorten it when it is more than 1 foot long. Leading shoots of these varieties that are more than 1 foot long should be reduced to this length. When they are appreciably more than 1 foot long, the shortening should be done during May rather than during Winter, because less vigour tends to result from pruning in Spring. Sometimes it may be necessary to remove the leading shoot together with a part of the branch by cutting back to a shoot or spur to eliminate bare wood. Occasionally for undervigorous trees, a reduction in the length of stem is needed, then 2 to 6 feet should be removed by pruning to a shoot or spur. The greater the increase in vigour desired, the greater the length of stem to be removed. From the foregoing remarks it will be appreciated that the chief function of the leading shoot is to provide an extension of the main stem to become furnished with productive material.

The Side Shoots, Spurs and Stubs.

(i) Trees with Little New Season's Growth.

For trees of this classification, little pruning is needed and what is recommended should be done during Winter. There may be a few maiden shoots more than 9 inches long, and they should be shortened to leave them as short stubs 2–3 inches long. Furthermore, one-half of those that are less than 9 inches long should be shortened similarly. Young shoots that are left unpruned generally have blossom buds or spurs formed on them by the time they are two years old; they should then be shortened to leave two or three of the blossom buds. Sometimes they are bare of either blossom buds or leaf buds; then

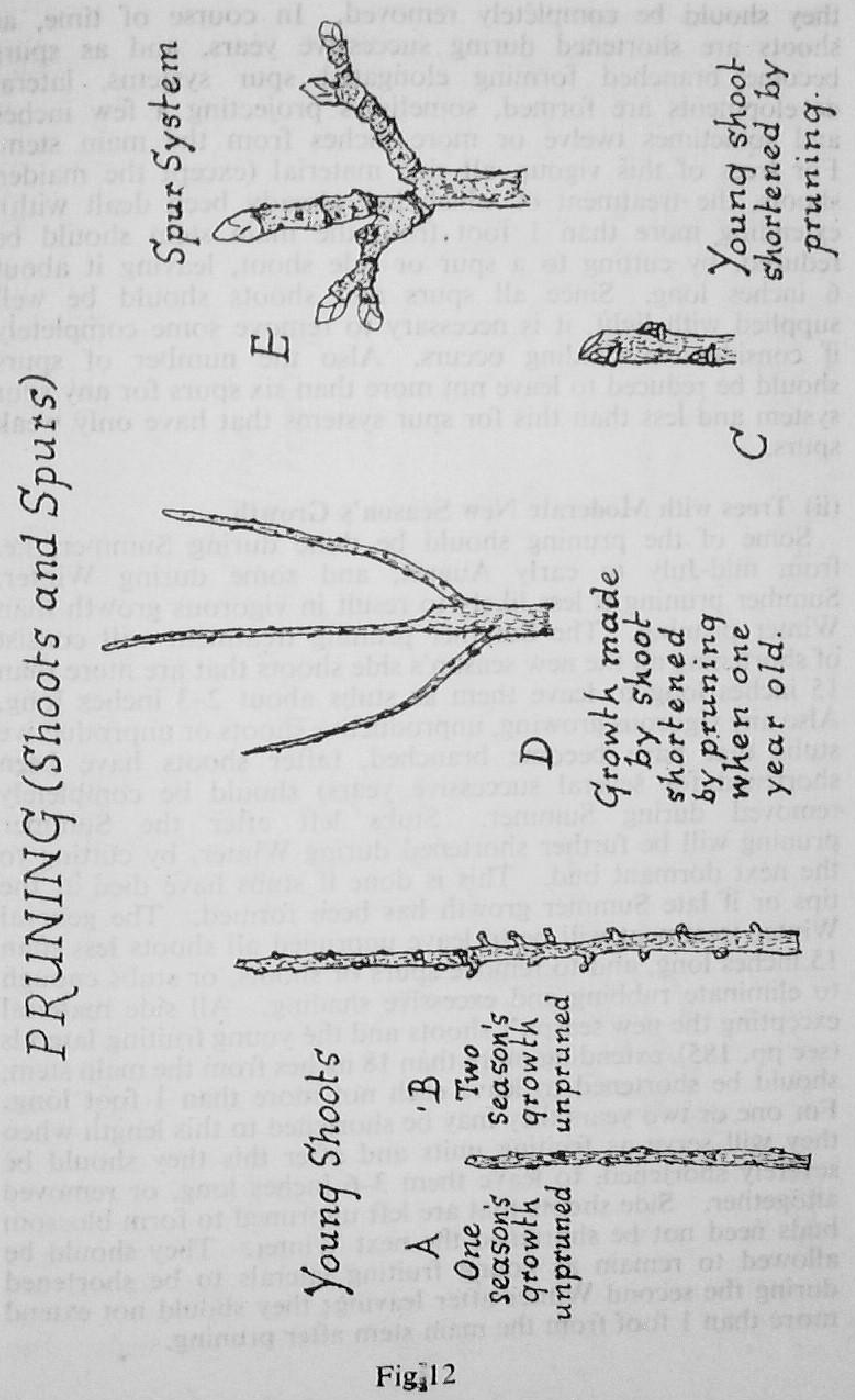
PRUNING (Shoots and Spurs)
Young Shoots
A One season's growth unpruned
'B Two season's growth unpruned
D Growth made by shoot shortened by pruning when one year old.
C Young shoot shortened by pruning.
E Spur System

Fig. 12

they should be completely removed. In course of time, as shoots are shortened during successive years, and as spurs become branched forming elongated spur systems, lateral developments are formed, sometimes projecting a few inches and sometimes twelve or more inches from the main stem. For trees of this vigour, all side material (except the maiden shoots, the treatment of which has already been dealt with), extending more than 1 foot from the main stem should be reduced, by cutting to a spur or side shoot, leaving it about 6 inches long. Since all spurs and shoots should be well supplied with light, it is necessary to remove some completely if considerable shading occurs. Also the number of spurs should be reduced to leave not more than six spurs for any spur system and less than this for spur systems that have only weak spurs.

(ii) Trees with Moderate New Season's Growth.

Some of the pruning should be done during Summer, i.e. from mid-July to early August, and some during Winter. Summer pruning is less likely to result in vigorous growth than Winter pruning. The Summer pruning treatment will consist of shortening all the new season's side shoots that are more than 15 inches long to leave them as stubs about 2–3 inches long. Also any vigorous growing, unproductive shoots or unproductive stubs that have become branched, (after shoots have been shortened for several successive years) should be completely removed during Summer. Stubs left after the Summer pruning will be further shortened during Winter, by cutting to the next dormant bud. This is done if stubs have died at the tips or if late Summer growth has been formed. The general Winter treatment will be to leave unpruned all shoots less than 15 inches long, and to remove spurs or shoots, or stubs enough to eliminate rubbing and excessive shading. All side material excepting the new season's shoots and the young fruiting laterals (see pp. 185), extending more than 18 inches from the main stem, should be shortened to leave each not more than 1 foot long. For one or two years they may be shortened to this length when they will serve as fruiting units and after this they should be severely shortened, to leave them 3–6 inches long, or removed altogether. Side shoots that are left unpruned to form blossom buds need not be shortened the next Winter. They should be allowed to remain as young fruiting laterals to be shortened during the second Winter after leaving; they should not extend more than 1 foot from the main stem after pruning.

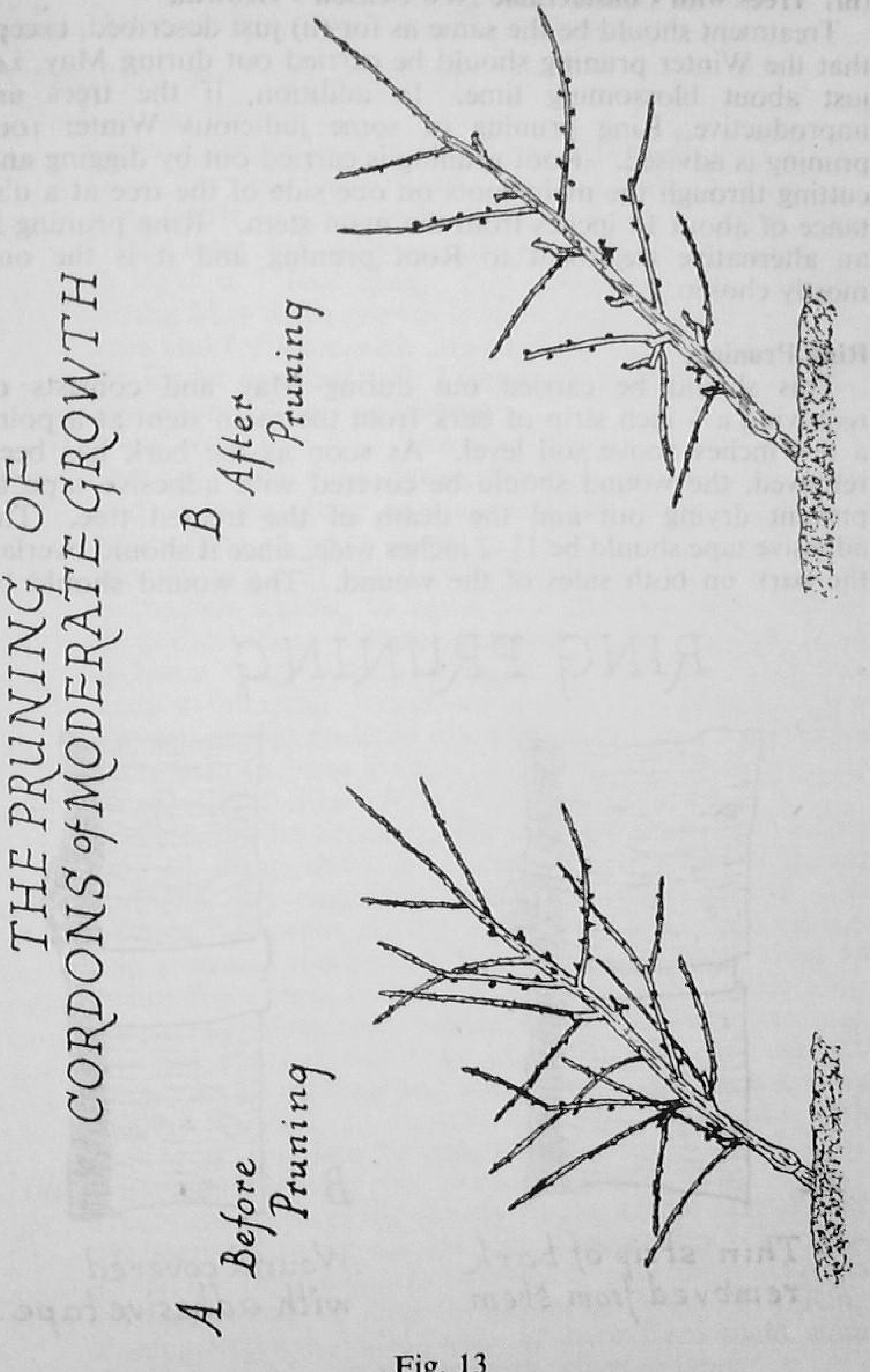
THE PRUNING OF
CORDONS of MODERATE GROWTH
A Before Pruning
B After Pruning

Fig. 13

(iii) Trees with Considerable New Season's Growth.

Treatment should be the same as for (ii) just described, except that the Winter pruning should be carried out during May, i.e. just about blossoming time. In addition, if the trees are unproductive, Ring pruning or some judicious Winter root pruning is advised. Root pruning is carried out by digging and cutting through the main roots on one side of the tree at a distance of about 18 inches from the main stem. Ring pruning is an alternative treatment to Root pruning and it is the one mostly chosen.

Ring Pruning.

This should be carried out during May and consists of removing a ½ inch strip of bark from the main stem at a point a few inches above soil level. As soon as the bark has been removed, the wound should be covered with adhesive tape to prevent drying out and the death of the treated tree. The adhesive tape should be 1½–2 inches wide, since it should overlap the bark on both sides of the wound. The wound should be

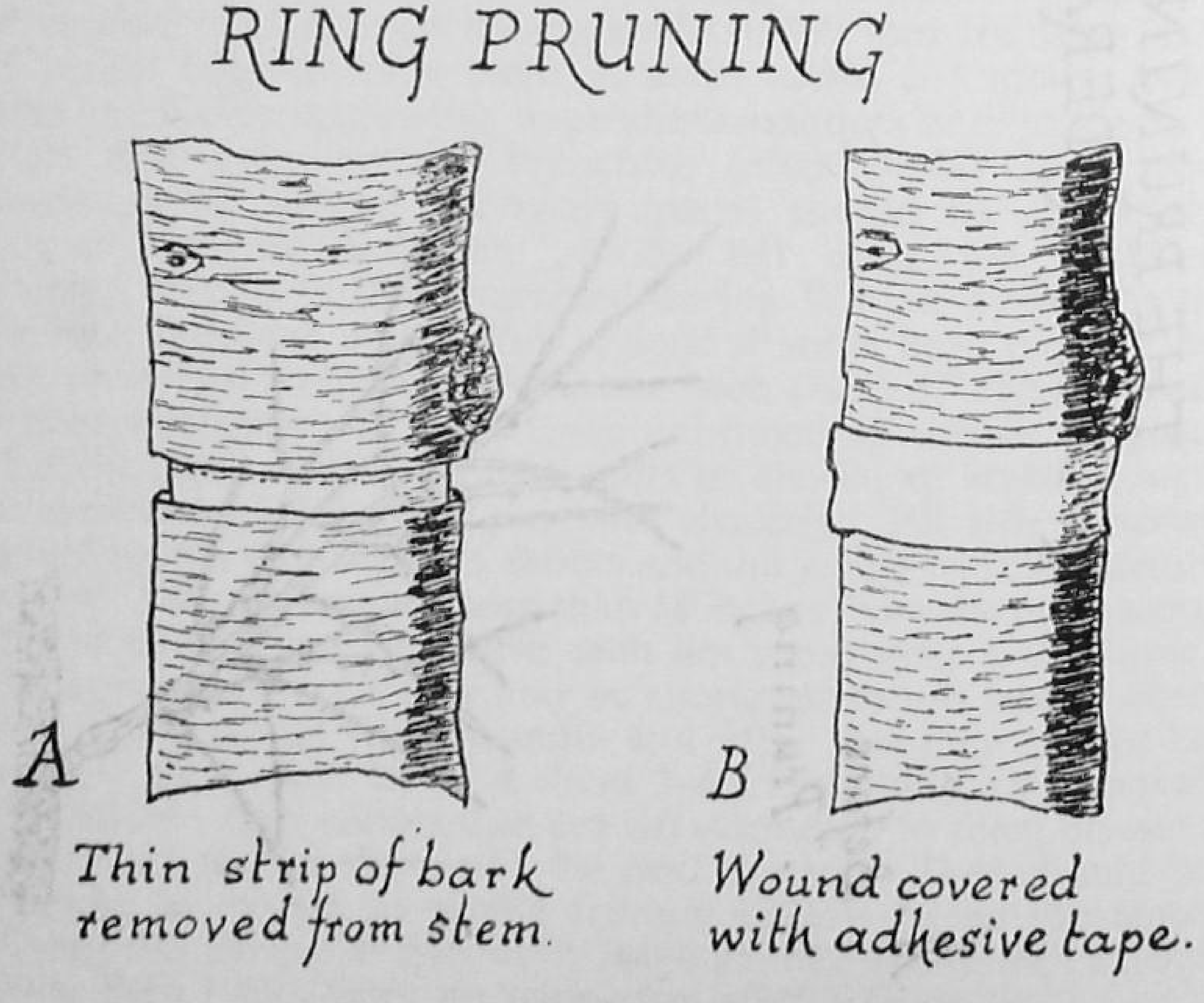

Fig. 14

covered by, but not filled in with, the adhesive tape so that healing tissue (callus) can be readily formed.

SUMMARY OF TREATMENT.

The Leading Branch.

Leave a single leading shoot unpruned, except for sorts liable to yield bare wood. Shorten one year trees of sorts liable to yield bare wood, to leave the stem about 2 feet long and subsequently shorten the leading shoot to leave it 1 foot long. For established trees, shorten during May when growth is vigorous. For under-vigorous trees and for trees with considerable bare wood, remove the leader together with 2 feet or more of the main stem.

The Side Shoots, Spurs and Stubs.

(*i*) *Trees with Little New Season's Growth.*

Pruning to be done during Winter. Shorten all shoots over 9 inches long and one-half of those less than 9 inches long to leave them as "stubs" 2–3 inches long. Shorten two year old side shoots that were left unpruned as maiden shoots, to leave 2–3 blossom buds, remove altogether those without blossom buds. Reduce spurs to leave spur systems with six blossom buds or less. Reduce material where considerable shading occurs. Shorten all old material extending more than 1 foot from main stem to leave it about 6 inches long.

(*ii*) *Trees with Moderate New Season's Growth.*

Shorten, during Summer, side shoots more than 15 inches long to leave stubs 2–3 inches long. Remove during Summer very vigorous shoots and unproductive stub systems. Shorten, during Winter, old side material (i.e. side material more than two years old) more than 18 inches from stem to leave it approximately 1 foot long. Shorten the oldest side material to leave it 3–6 inches long. Do not shorten one year and two year side shoots. Eliminate all rubbing and any material causing excessive shade. Shorten, to nearest dormant bud, stubs with dead wood and late Summer growth.

(*iii*) *Trees with Vigorous New Season's Growth.*

Treatment to be as (ii) already stated, except that Winter treatment is to be carried out during May. For unproductive trees, either Root-prune by severing main roots during Winter, or Ring-prune during May. For Ring pruning, remove ½-inch strip of bark from main stem near soil level, cover wound with adhesive tape.

(b) DWARF PYRAMIDS.

The chief point of difference between the treatment of Dwarf Pyramids and Cordons occurs during the early formative years. The nature of the Dwarf Pyramid tree with its erect stem and many side branches demands a fairly detailed treatment of leaders. Once a branch is formed, the treatment of the side shoots, spurs and stubs is not dis-similar from that of the Cordon tree.

The Formative Years.

The treatment during the first few years is mainly directed towards the establishment of a central erect stem and short branches radiating from the centre stem.

(i) The Centre Leading Shoot.

Starting with a single-stemmed, one-year tree, the top should be removed to leave it about 2 feet tall. A shoot is trained from this pruned back stem, invariably the one formed from the top bud, to take a vertical position and so continue the extension of the centre erect stem. This shoot is cut back during the following Winter and about 1 foot is then retained, leaving the tree about 3 feet tall, in all. The actual length that can be left is governed by the amount of growth made. If poor growth is made, all that can be done is to remove either the terminal bud or a few inches of the short shoot. If vigorous growth is made, up to 18 inches may be retained. The procedure outlined for the second year is repeated on the central leading shoot each year, until a tree is about 5 feet tall; after this, no further branch division from the central stem is required. If only poor or moderate growth is being made at this stage, the central shoot may be left unpruned for one year, allowed to form blossom buds and subsequently shortened, to leave most of the blossom buds. If vigorous growth is being made, the entire shoot should be removed during May by cutting back to the topmost side shoot.

(ii) The Side Branch Forming Shoots.

Each year, in addition to the central leading shoot, there should be a number of side shoots which are employed to form short branches. Some of these will be shortened to yield more shoots for the following year and some will be left unpruned to produce blossom buds. Very erect shoots, especially those neighbouring the erect central shoot, should be removed completely. When two shoots rub, or nearly rub, one of them

should be eliminated, retaining the one considered to be the more desirable. Furthermore, near-neighbouring shoots, that is, those less than 9 inches apart, should not overlap and extend in identically the same direction, one or other should either be severely shortened, or removed altogether. The former course should be chosen when the side of the tree in question would otherwise be left rather bare of shoots. For the first one or two years, if there are only a few suitable side shoots to form branches, all of them should be shortened, leaving them about 6–9 inches long after pruning. So that the longest shoots shall not form dominant branches, it is necessary to prune them so that they are left shorter than those of more moderate vigour. Once trees are firmly established and are producing several branch-forming shoots each year, either direct from the main stem or as extensions of existing branches, one half of them may be left unpruned. It is best to alternate pruned shoots with unpruned ones so that each type is evenly distributed throughout a tree. The pruned ones should be shortened to leave them about 6–9 inches long. Shoots that are designed to form branches and the principal shoots that extend the length of an existing branch are referred to as "Leaders." Leaders that are formed from the pruned shoots of one season should be left unpruned the next season. The unpruned leaders of one season should have the new season's growth removed the next season and after two or three seasons, when they should have fruited for one or two years, they should be shortened to within 6 inches of the main stem, being so severed as to leave a young spur or shoot in the terminal position. For small-sized trees of the Dwarf Pyramid type, it is unwise to leave long vigorous leaders unpruned. In the event of a large majority being vigorous, the pruning should be done during May and it may be necessary to Root prune or Ring prune as advised for Cordons (p. 166).

(iii) Bud Treatment.

Some detailed individual bud treatment can be usefully employed on a central leading shoot, especially a vigorous one. After the shortening, the second bud from the top should be prevented from forming a strong growing erect shoot of the type it is necessary to remove. It is wise to divert the vigour to other buds lower down the stem which tend to form shoots that grow out at a wider angle. Thus the penultimate bud should be removed altogether. Where there is a strong growing erect central shoot, light pruning is desirable (the suggestion

already made is to leave 18 inches). Having carried this out, it is necessary to avoid bare wood resulting upon the lower portion; to prevent this, a small wedge-shaped piece of bark may be removed immediately above each bud from which growth is wanted. This practice is referred to as "*notching*" and is done about ½ inch above selected buds. When the shoots selected for the formation of branches are more erect than desired, they should be pruned to leave one bud above that required to grow, and a knife cut, referred to as "*nicking*," should be made below the topmost bud (see Fig. 17, p. 178). "Nicking" the bud checks vigorous growth, and pruning one bud higher ensures greater outward growth.

The Established Tree.

(i) Trees with Little New Season's Growth.

The main pruning consists of regulating the length of the branches and reducing the number of spurs, and this is done during Winter. Branches that are more than 2 feet long should be shortened to leave them 9 inches to 1 foot long. All spur systems with more than four spurs should be reduced to leave 3–4 spurs. Eliminate rubbing and excessive shade either by shortening, or by cutting out completely, offending shoots, spurs or branches. Shorten alternate side shoots, that is about one-half of all shoots, to leave them about 2–3 inches long and leave those that remain full length. Invariably, most growth is made at the head of trees, and trees that have made little growth on the lower branches are often vigorous at the head. In such cases, the pruning described under this heading only applies to the lower branches. The more vigorous branches should be dealt with as for the trees of the vigour group they represent (see sections (ii) and (iii) to follow).

(ii) Trees with Moderate New Season's Growth.

Some pruning will be done during Summer and some during Winter. The treatment of leading shoots has already been dealt with in the section dealing with "The Formative Years" (p. 168). All the new season's side shoots more than 15 incnes long should be shortened during Summer, (i.e. mid-July to early August) leaving them as stubs 2–3 inches long. Stubs that are unproductive and have become branched due to pruning for two or more years should be removed during Summer. Pruning to eliminate rubbing and near crossing should also be done during the Summer. The Winter pruning will consist of removing all late growth and dead tips from the Summer pruned

stubs. Also the number of spurs and shoots should be reduced where much shading occurs. The proximity of neighbouring trees usually demands the shortening of branches when they are more than 2–3 feet long and this should be done during Winter by cutting them back to a spur or side shoot within about 1 foot of the main stem. Sometimes the head of the tree will need treating as for trees of vigorous growth (see next section (iii)).

(iii) Trees with Considerable New Season's Growth.

The pruning should be the same as for (ii) just described, except that the treatment advised for Winter should be carried out during May. For unproductive trees, Root pruning or Ring pruning as suggested for vigorous Cordon trees is advised (see p. 166). For trees where the head is more vigorous than the lower branches, a Ring pruning should be given at a position on the main stem directly below the most vigorous portion.

SUMMARY OF TREATMENT.

The Formative Years.

(*i*) *The Central Leading Shoot.*

Remove tops of one year trees to leave stem about 2 feet tall. Shorten central leading shoot during subsequent years to leave it about 1 foot to 18 inches tall, depending on vigour. When tree is 5 feet tall, leave unpruned if not of more than moderate vigour and prune back to blossom bud the following year. If vigorous when 6 feet tall, remove central leading shoot during May.

(*ii*) *The Side Branch Forming Shoots.*

Remove completely shoots that are very erect, also shoots that rub or nearly rub. Remove or severely shorten one of two shoots less than 9 inches apart when they overlap and extend in the same direction. For the first few years shorten side shoots to leave them 6–9 inches long. For trees with numerous side shoots, shorten every alternate shoot to leave them 6–9 inches long, and leave the leading shoot (formed from these) unpruned the next season. Alternate shoots left unpruned should have the new season's leading growth removed the following year and after cropping for 2–3 years the branch should be shortened to leave about 6 inches. Vigorous leaders should be pruned and when the majority are vigorous, pruning should be carried out during May.

(*iii*) *Bud Treatment.*

Remove penultimate bud (bud number two) from the

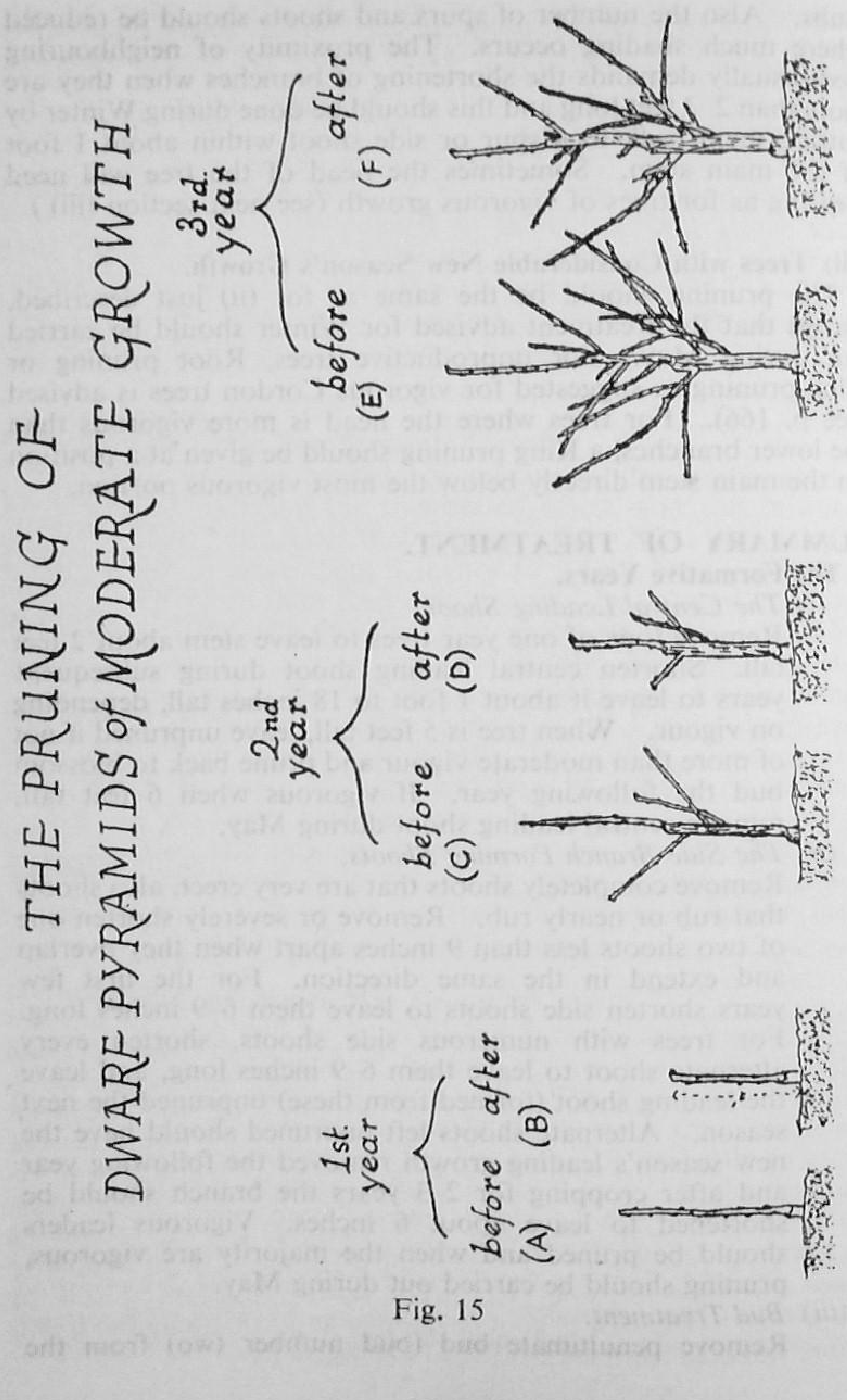
THE PRUNING OF
DWARF PYRAMIDS of MODERATE GROWTH
1st. year
before (A)
after (B)
2nd year
before (C)
after (D)
3rd. year
before (E)
after (F)

Fig. 15

pruned central leading shoot. Notch above buds where growth is wanted and where bare wood would otherwise occur.

The Established Tree.

(*i*) *Trees with Little New Season's Growth.*
All pruning should be done during Winter. All branches more than 2 feet long should be shortened to leave 9 inches to 1 foot. Reduce spurs to leave not more than 3–4 per spur system. Eliminate rubbing and excessive shade. Shorten alternate side shoots to leave 2–3 inches long. When the head is more vigorous than lower branches, prune according to vigour category.

(*ii*) *Trees with Moderate New Season's Growth.*
Shorten during Summer to leave 2–3 inches long all side shoots more than 15 inches long. Remove unproductive stub systems during Summer also shoots that rub or nearly rub. During Winter, remove late Summer growth, dead tips; reduce spurs and shoots where much shading occurs also shorten branches that are too long, to within 1 foot of the main stem. Heads that are very vigorous, treat as (iii) (next section).

(*iii*) *Trees with Vigorous New Season's Growth.*
Treatment to be as (ii) (previous section), except that Winter treatment should be carried out during May. For unproductive trees, Root prune or Ring prune.

APPLES, PEARS, PLUMS, DAMSONS AND CHERRIES (normal planting systems).

Whether or not to Prune During the Season of Planting.

There is much divergence of opinion as to whether trees should be pruned during the season of planting or be left unpruned for one year. Neither course is suited to every occasion and the better expedient for particular cases is determined by the amount of new season's growth that one is entitled to expect. If good growth can be expected during the first growing season, pruning should be done during the season of planting; otherwise one year will be wasted in the establishment of the trees. If there is reason to believe that negligible growth would be made after pruning in the season of planting, it is preferable to defer pruning for one year. The extra leaves produced by unpruned trees assist in root development and thereby the tree is more fitted to form shoots the following year.

Different circumstances result in the production of poor or good growth. Good growth may be expected when young trees (i.e. 1–4 years old) are planted early (i.e. November to early February, but preferably before January), into fertile conditions, or conditions where special measures are taken, such as surface mulching with dung (see p. 135). Poor growth may be expected with trees more than 4 years old, also with trees planted after February, or where the soil conditions are not conducive to good growth.

THE FORMATIVE YEARS.

Forming the Head.

The pruning is done during Winter, except for Plums and Cherries which are pruned during Spring because of their susceptibility to diseases such as Silver Leaf and Bacterial Canker (see pp. 234, 239). The head of a tree is formed from shoots which grow out from a single erect stem. In the course of the years, the single erect stem is referred to as the " trunk " and shoots selected from it constitute the main framework branches of the tree. The trunks differ in height, the differences depending upon whether the trees are intended as Bush, Half-Standards or Standards (see p. 46) and the main framework branches are formed both at and near the top of the trunk. A one year old single-stemmed tree designed for the Bush type, is usually tall enough to prune in the hope of securing a number of shoots for forming the head. Sometimes a one year old tree already has side shoots, called " feather," which are very acceptable as branch-forming shoots. Very often, especially with apples and pears, more than one year must elapse before the single stem is tall enough for pruning to form the heads of Half-Standards and Standard trees.

Whether for Bush, Half-Standard or Standard trees, the head is formed in the same way, that is by removing the top of the stem to leave it 6 to 8 inches higher than the position at which the lowest branches are wanted. If at the outset, there are any shoots too low down the stem for the purpose of forming branches, they should be removed completely. For Standard trees with slender stems, such side shoots should be removed in two stages, they should be left as short stubs 3–4 inches long for a year and removed completely a year later. This practice helps to strengthen the main stem. The removal of the top portion of the erect, young stem is designed to stimulate buds to form shoots at positions where branches are wanted (see p. 150). This principle will apply for a number of years, shoots

will be shortened at or near positions where an extension and division of the branch system is wanted, and in the case of some varieties of apples, pears and plums, it should apply as long as the tree remains. Trees which have feather, consisting of two or more shoots radiating from different sides of the erect stem and occurring at suitable heights to form branches, are dealt with as if they were one year older than they are. When there are only two pieces of feather, the erect central stem is shortened like the single stemmed tree, but when there are three or more feathers, the central stem is cut clean out at the junction it makes with the uppermost feather. If there is only one such side shoot or two on the same side of the tree, they should be removed; otherwise difficulty will be experienced in forming a shapely head, (i.e. a well-arranged branch system making relatively even development to occupy the orchard space available).

In spite of the fact that, to all intents and purposes, all single-stemmed trees are treated similarly for the first pruning, it does not follow that they will respond similarly, nor that they will require identical treatment for the second pruning. It may be that the first pruning has been done in the nursery and that trees are planted out with one year heads. It matters not whether the pruning has been done in the nursery or in the plantation, there are likely to be considerable differences; some trees may have formed several shoots near the top of the stem and these may be roughly spaced at even distances around it; other trees may have made negligible growth, and yet others may have made good growth on one side of the stem and poor growth on the other. Ideally, a tree at this stage should have three to five shoots, none less than 1 foot long, they should be regularly spaced, to give a symmetrical appearance round the main stem and they should point outwards, away from the stem instead of being erect.

The procedure to adopt when only two shoots are present, is to remove one completely, retaining the more erect which should be shortened to leave the tree not more than two or three inches taller than after the first pruning. The tree that is built up from two main branches should be avoided, because in later years it is liable to split at the fork. Only small dimensions are covered by the type of tree under discussion, whereas in a few years dimensions will be greatly increased. In view of this, more than five shoots to form branches would usually be excessive. For trees that have more than five shoots, the surplus ones should be completely removed choosing for

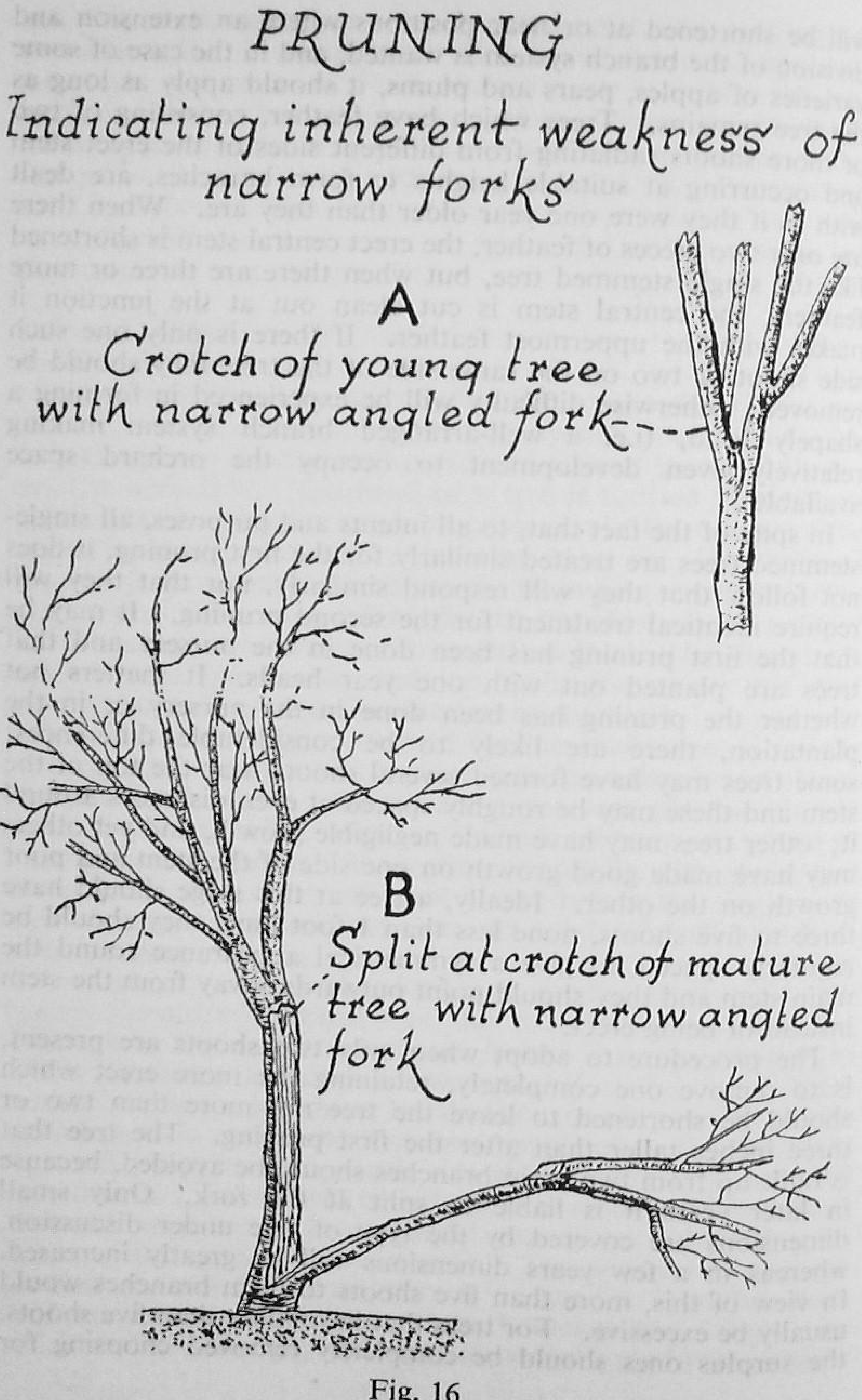
PRUNING
Indicating inherent weakness of narrow forks
A
Crotch of young tree with narrow angled fork
B
Split at crotch of mature tree with narrow angled fork

Fig. 16

the purpose any very much shorter or longer than average. Very erect growing shoots normally make an unsatisfactory type of branch, they form weak forks, they are the least productive branches, they grow vigorously at the tops and form bare wood at the bottom. It is only justifiable to retain erect shoots when they are employed for the production of other less erect shoots but in no circumstance should they be used for such plum varieties as Early Laxton, Belle de Louvain or Oullin's Golden Gage, since branches with narrow forks split out of them very readily.

Again, one of two shoots should be removed when one overlaps the other and they grow in the same direction. When one shoot shades another in this manner, their development and efficiency are impaired if they are both retained.

At this stage, each shoot that is retained to become one of the main branches, should be shortened. For trees that have made good growth on one side and poor growth on the other, the poor side should, if possible, be left the higher or longer after pruning, to avoid an unbalanced head. Furthermore in order to stimulate better growth on the weak side for the next growing season a notch (see p. 170) should be made on the main stem directly above the point of origin of each of the weak shoots. In cases where fairly erect shoots are employed for the formation of branches, it is a good practice, when shortening, to select the bud which it is intended should grow outwards and then to shorten at a position one bud higher; the highest bud should then be nicked (see p. 170).

Trees that have formed no young shoots after the first pruning, will have formed blossom buds. The pruner should remove the flower trusses from these when the flowers are nearly open, by cutting them off; but such leaves as have been formed should be retained.

In cases where it is possible to select maybe three, four or five young shoots (this is possible with most trees), the individual shoots should be shortened for two main reasons; firstly because as the spread or width of a tree increases, a further supply of young shoots is needed for the purpose of forming more branches, and secondly because by pruning young branch-forming shoots, they are prevented from cropping prematurely, and retardation of the development of the tree is avoided thereby.

The length to be left on branch-forming shoots, or leaders (see p. 181) depends on their original length and upon the position at which further leaders are required. After each

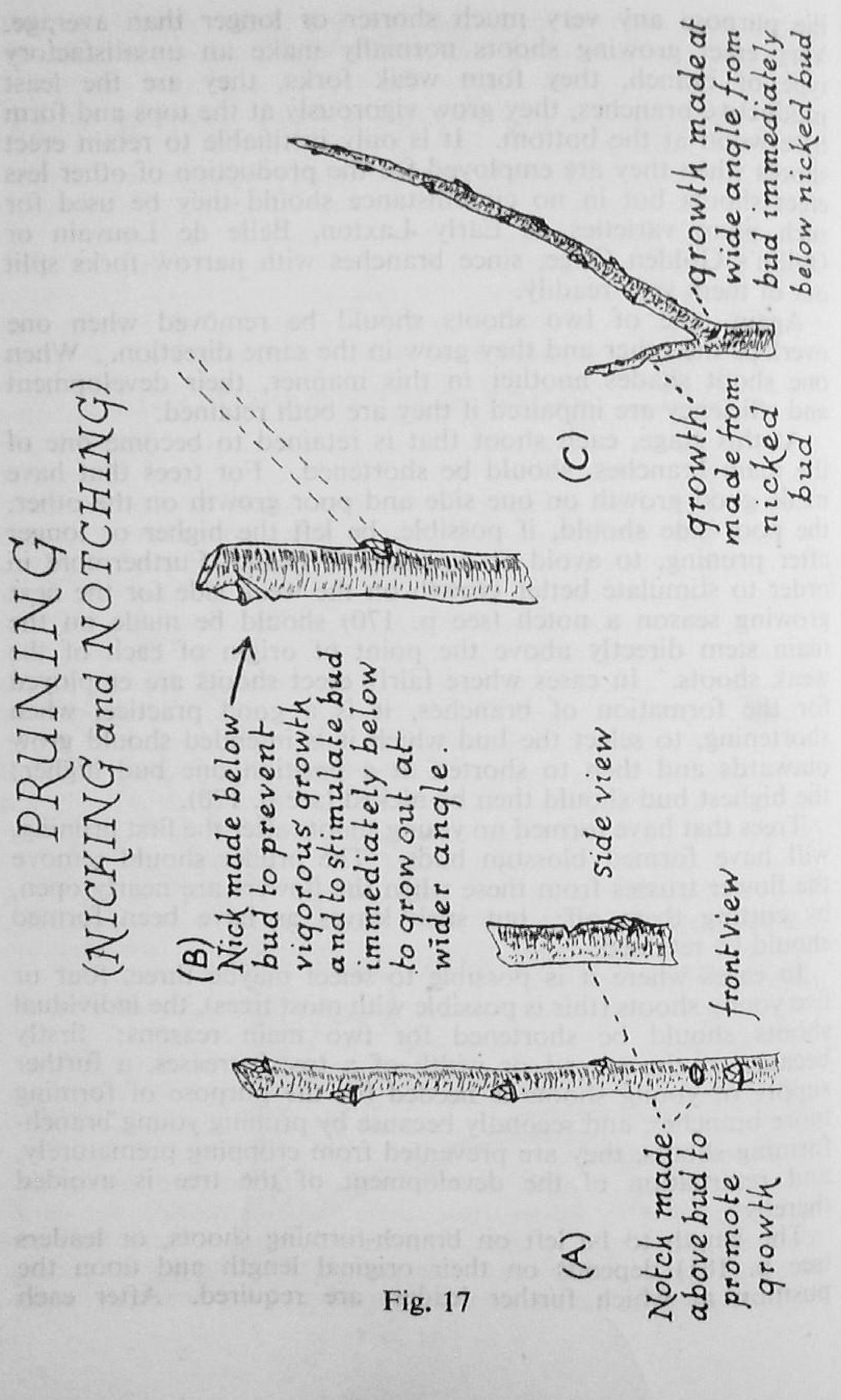
PRUNING
(NICKING and NOTCHING)
(B) Nick made below bud to prevent vigorous growth and to stimulate bud immediately below to grow out at wider angle.
side view
front view
(A) Notch made above bud to promote growth
(C) growth made from nicked bud
growth made at wide angle from bud immediately below nicked bud

Fig. 17

leader has been pruned, the top few buds should be well separated from those of the nearest neighbouring leaders. It is from the few buds nearest the top of a pruned shoot that most new growth is formed; so the result of leaving the tops of a few pruned leaders very near together is crowded shoot growth and this renders severer pruning necessary later. Sometimes, when only poor growth has been made, crowded shoots must be left. When growth is good, in order to achieve good spacing between leaders, some should be only lightly pruned, while others are shortened by one-half to two-thirds. After pruning, the tops of the leaders should not be nearer than nine inches. There are two reasons why it is an advantage to prune leaders with different degrees of severity; one is that when some of the shoot growth is formed nearer the main stem than the rest, shoots will be more evenly dispersed throughout a tree than if all leaders were reduced to one height. The other reason is that it is desirable to have some of the branches bearing fruit and bending outwards sooner than others; and differential pruning helps to bring this about. Thus if there are four leaders, two should be pruned to leave them three or four inches shorter than the others; if there are five leaders, two should be left relatively short and three relatively long. It is hardly necessary to emphasise that opposite sides of a tree should appear balanced after pruning, with an avoidance of long leaders on one side and short ones on the other. When there are only three leaders, they should be pruned to leave all roughly the same length; pruning to differential length should be deferred until there are more.

The Subsequent Pruning Treatment of:—

Apples. Sturdy wooded sorts such as Bramley's Seedling, Newton Wonder and Worcester Pearmain, when making vigorous growth.

Pears. Doyenne du Comice, when making vigorous growth.

Cherries.

Plums.

Damsons.

(i) General Treatment.

Once the head has been formed, detailed pruning is not required for the stone fruits under consideration, nor is it required for certain varieties of apples and pears whilst they are making vigorous growth. The principal pruning will consist of providing branches and shoots alike with adequate space

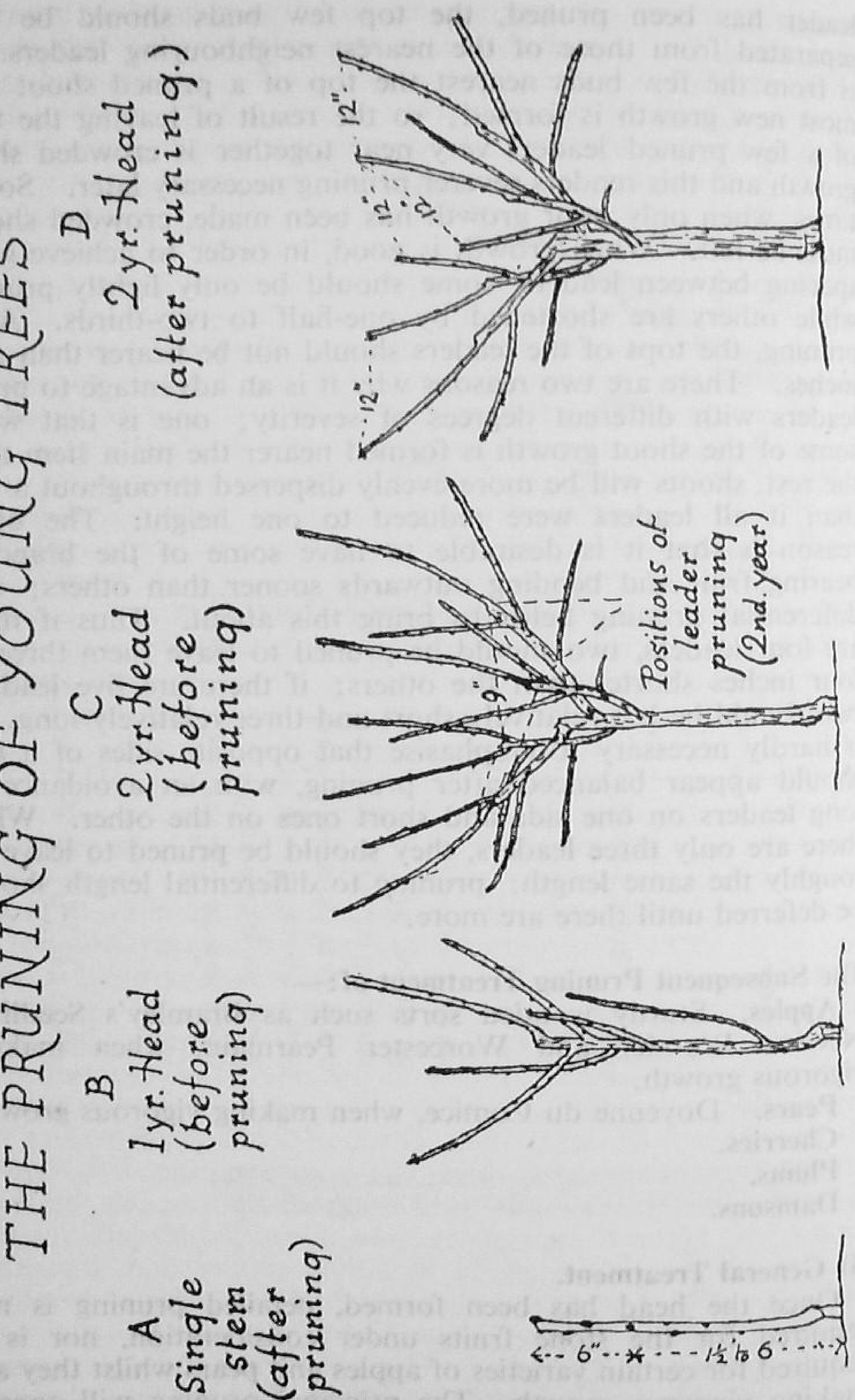
THE PRUNING OF YOUNG TREES
A Single stem (after pruning)
B 1yr. Head (before pruning)
C 2yr. Head (before pruning)
D 2yr. Head (after pruning)
Positions of leader pruning (2nd. year)
6"
1½ to 6'
9"
12"

Fig. 18

and light, and of giving preference to outward-growing branches over those that are erect. This means that when two shoots chafe, or nearly so, one of them should either be removed, or, if there is a suitable position from which growth is wanted, be shortened; the same should be done where branches are actually rubbing, or are very close together, so that one shades the other and there is little room or facility for the formation of side shoots. Very erect branches should either be removed or shortened to a place where there is an outward growing branch or shoot; nevertheless some degree of tolerance should be allowed in this matter with varieties which naturally tend to grow erect. When a branch or a strong shoot, that originates on one side of a tree, is directed to the opposite side it should be removed. Similarly all shoots neighbouring leaders and competing with them should be removed. While these recommendations apply for the early years to all fruits under this heading, there are slight divergencies of treatment after they are well established. In the case of cherries and plums, the crossing of small shoots and branches is tolerated to a greater extent than with apples and pears. Also the removal of large branches should so far as possible, be avoided in the case of plums and cherries, especially the sorts subject to the disease Silver Leaf (see p. 234).

(ii) Treatment of Leaders.

Some leader pruning is required after the second pruning, especially with apples, pears and plums. When young trees are not making more than moderate growth, all the young shoots chosen as leaders (and they should not number more than ten) should be shortened in accordance with the suggestions for the second pruning (see pp. 175–179). When good growth is being made, a treatment transitional between pruning all the leaders and leaving the majority unpruned should be given. It is better to spread the change from pruning to no pruning over one or two years, rather than to prune all leaders one year and none of them the next. One effect of leaving all leaders unpruned is to hasten cropping. As a general rule, it is unwise to impose this hastening process upon all branches at the same time. It is better to permit say, one-half of the leaders to come into cropping, and widen by so doing, sooner than the other half. To do this, alternate leaders should be shortened by about one-third to one-half, and the remaining intermediate ones should be left full length. Somewhat more leader pruning should be done for Worcester Pearmain, than for the other two apple varieties (see pp. 162, 179). Such a practice helps con-

siderably to reduce the breakage of branches which is liable to occur, especially in the case of plums, when heavy crops are carried by all branches in the same year. Furthermore, it follows that the practice mitigates against the tendency for biennial cropping (see pp. 193–199) to become established early in the life of trees. After the transition stage, routine leader pruning should be discontinued with erect growing trees, but with spreading trees it is of advantage to shorten a few shoots to form new branches each year. Such shoots should not be chosen at extreme ends of existing branches, but rather at positions nearer the main stem where branches bend outwards and assume a more or less horizontal position. New branches formed in this manner may be spoken of as replacement or renewal branches.

The Subsequent Pruning Treatment of:—

Apples. All excepting sturdy wooded sorts which have been dealt with already (see pp. 57, 179).

Pears. All excepting vigorous Doyenne du Comice (see pp. 58, 179).

With most varieties of apples and pears considerably more detailed pruning is required than with plums or cherries A simple classification of the material which may require attention will help to clarify a description of the pruning technique. There are four main types of material viz. (i) Branches, (ii) Leaders, (iii) Laterals (i.e. side shoots one year or older not used as leaders), (iv) Spurs (i.e. short shoots terminated either by a blossom bud or one yielding a rosette of leaves) (see p. 161).

(i) Treatment of Branches.

Branches are formed from selected leaders. A branch is the product of a previous season's leader inasmuch as only one-year-old branch-forming shoots are termed leaders; when they are more than one year old, they assume the role of branches. Just as a branch depends for its formation upon a leader, so it depends on leaders for its subsequent extension. A branch becomes higher or longer by the repeated selection of one new leader at the top of an existing one over several successive years (see p. 168). Certain features are required of branches in order to make them efficient members of a tree. It is these features that provide a clue to the course to be adopted when pruning.

First and foremost, branches are required to supply and maintain a productive bearing surface; tall, erect branches are seldom satisfactory for these purposes. In view of this it is

usually a correct procedure to eliminate centrally-placed, erect branches, either by complete removal or by taking off the top portion, and to keep the lower part if it gives rise to one or more outward spreading branches.

The leaves borne by the shoots and spurs on the branches require plenty of light in order to make branches productive members of a tree. From this simple fact follows the necessity for regulating the number and position of branches in relation to the size of a tree. For young trees, suggestions have already been made regarding the spacing of leaders (see p. 179), as a safeguard against excessive shading. A similar policy should be adopted for older trees. Various faults necessitate the removal or shortening of a branch; (*a*) when two branches cross so that they rub or nearly rub; (*b*) when one branch lies directly over another less than 2 feet away; (*c*) when two branches lie parallel, side by side, less than 18 inches apart; (*d*) when a side branch is directed towards the centre and towards the side of the tree opposite its parent branch. Branches should also be removed or shortened when they are too low to afford reasonable facilities for cultivation.

When trees are big enough, but fail to yield sufficient new season's growth for the production of large enough fruit, a reduction of branch surface should be effected. This should be done by drastically shortening some of the branches, say one out of every four or six of the total number of subsidiary, rather than main branches, which are represented by the principal leading shoots. They should be shortened to within one or two feet of their junction with their respective parent branches. This practice of shortening branches when applied to a whole tree is spoken of as " dehorning " but when applied to a proportion of the branches it is referred to as " partial dehorning." In the event of a system of establishing replacement branches being followed (see p. 182 and also what follows now), the partial dehorning is best done by shortening to a replacement branch or shoot suitable for forming a new branch.

(ii) Treatment of Leaders.

As a general rule, it is good practice to shorten leaders when an increase in the length of a branch is wanted and when the production of new leaders and laterals is required. A leader should be shortened so that the subsequent young shoots are formed at positions where they are most needed. At this stage no two neighbouring leaders, after pruning, should be nearer than 12 inches from tip to tip for small sized trees, and about

2 feet for large sized trees. It is not advisable to shorten leaders at the extreme ends of branches that are high enough or long enough, but a few side-shoots occurring lower down such branches should be chosen and shortened so that new replacement branches are in process of being formed. Very erect shoots and those that are directed towards the centre of a tree should not be chosen for branch-forming purposes. For preference, young shoots that are designed to form replacement branches should be held more erect but should possess a tendency to fall in the same direction as the parent branch, except when the parent branch is too erect. If the parent branch is too erect, shoots more outwardly directed should be chosen. For vigorous trees, that is those making considerable new season's wood, it is not desirable to shorten all the leaders even if the branches are not tall or long enough. To do so, invariably results in the production of an excess of young shoots at the tree tops. In such cases, it is preferable only to shorten every alternate leader.

For varieties such as Worcester Pearmain and Lord Lambourne apples, and Williams' bon Chrétien and Dr. Jules Guyot pears, long leaders should seldom be left unpruned, because branches formed by them are characterized by much bareness. Supposing, however, most of the leaders are long ones, and to prune them all would still further increase excessive vigour, alternate leaders only should be shortened and three or four buds on the lower half of each of the remaining ones should be notched (see p. 170), in order to stimulate the development of lateral shoots. Nevertheless if the principle of replacing branches is adhered to the temporary occurrence of some bare wood is to be preferred to excessive vigour.

(iii) Treatment of Side Shoots.

To a very great extent the side shoots should be looked upon as the material for producing spurs, and it is upon the spurs that the bulk of a crop is normally borne. From this it should not be inferred that once a tree is well furnished with spurs, there is little, if any, further use for side shoots. On the contrary, a grower will do well to foster a supply of side shoots every year, for by so doing he is providing for a regular supply of blossom buds, and this in turn makes possible the elimination of some of the oldest spurs each year.

It is already evident that all side shoots will not be employed for one and the same purpose during the same season. Some side shoots will be removed altogether, especially very vigorous erect ones that do not lend themselves to productive purposes,

and those that occupy positions that rob those better placed of their value. Just as a spacing of branches is necessary in order to make good use of orchard space, so the spacing of side shoots should not be neglected. Of the side shoots that remain, some will be employed for the formation of blossom buds and others for the production of a further supply of side shoots. Once side shoots have blossom buds, the majority of them will be retained for productive purposes. The term "laterals" is employed for side shoots of different ages. For convenience in describing pruning procedure for laterals, they are classified as: (*a*) One Year Laterals (i.e. Maiden Laterals) and (*b*) Laterals two years old and older (i.e. Bi-lats and Tri-lats).

(a) One-Year Laterals.

Excepting any that may be selected as leaders to form branches (see p. 183) maiden laterals will be dealt with in one of three ways. They may be: (i) completely removed, (ii) drastically shortened, or (iii) left unpruned. One of several reasons may indicate the desirability of completely removing a lateral. Tall-growing erect laterals and strong-growing ones, close to leaders, should be removed. When crossing or rubbing occurs near the base of a lateral, one of the two offending members should be eliminated. These removals will do much to provide space and light for the laterals that remain; but, in spite of this, there are other shoots that usually need to be removed solely because more valuable material is shaded by them. Disease on a shoot near its base may also be a valid reason for removal.

Of the maiden laterals that remain after the removals have been completed, some are normally required to form blossom buds as soon as possible and they will therefore be left unpruned. The others are shortened in order to stimulate a further supply of young shoots. The practice of leaving all young laterals unpruned should only be followed when trees are excessively vigorous; otherwise an excess of blossom buds and a deficiency of young shoots is likely. The pruning requirements in respect of lateral treatment are different for different varieties of pears and apples. Furthermore, trees of the same variety differ in vigour, that is in the amount of young one-year wood that has been formed, and this necessitates some differences in the proportions of maiden laterals shortened and left full length.

Trees with Vigorous Growth.

A greater proportion of maiden laterals should be left unpruned on trees that have made vigorous growth than on trees

that have made only moderate growth. Even for vigorous trees, that is those with numerous long, one-year-old shoots, treatment depends upon requirements: as to whether large fruits or only moderate sized fruits are required. Pear varieties like Fertility, Durondeau, Beurre Bedford and Marguerite Marillat and apple varieties like Crawley Beauty, Early Victoria, Lane's Prince Albert, Lord Derby, Laxton's Superb and Miller's Seedling should seldom be left with more than one-half of the one year laterals left unpruned. The remaining laterals should be shortened, which will in fact mean that every alternate maiden lateral will be shortened. For pear varieties such as Clapp's Favourite, Laxton's Superb, Dr. Jules Guyot, Williams' bon Chrétien and Conference and for apple varieties such as Cox's Orange Pippin, Tydeman's Early Worcester, Laxton's Fortune, Lord Lambourne, James Grieve, Ribston Pippin, Sunset and King Edward VII as many as two-thirds of the maiden laterals may be left full length and the remainder shortened. Since it is intended that new shoots rather than blossom buds should be formed on what remains of the laterals after they have been shortened, it follows that the shortening should be severe. Each lateral that is shortened should be left as a short stub 2–3 inches long.

Trees with Moderate Growth.

No change in principle is needed in lateral pruning between the vigorous and the moderately vigorous tree, the only difference is one of degree. The moderately vigorous tree is normally more productive than the vigorous tree and therefore a greater proportion of the laterals should be pruned in order to stimulate the maintenance of adequate vigour. Apple and pear varieties for which it was earlier suggested, under the heading "Trees with Vigorous Growth," that one-half of the maiden laterals should be shortened, will now require two-thirds, or two out of every three to be shortened. For the remaining sorts which need one-third shortening in their vigorous state, one-half should be shortened when they are only moderately vigorous.

Trees with Poor Growth.

When trees have only returned poor growth, all maiden laterals should be left unpruned except those required as leaders and those terminated by blossom buds. In the latter case, only the very tip should be removed. Most pruning for trees in this category will be directed towards a reduction of spur systems and branches (see pp. 183, 192).

(b) Laterals Two Years Old and Older.

A consequence of leaving one year laterals unpruned is that some attention must be given to them at a later date. The main purpose of leaving maiden laterals unpruned, is to facilitate the formation of blossom buds at an early date; when this is achieved, they should not be left unpruned indefinitely. It should be noted that they may also be left in order to provide leaf surface, just as they are on trees with poor growth to increase tree vigour, later on. Some trees form blossom buds very readily on unpruned laterals and on this account it is advisable to shorten them by the time they are bi-lats (i.e. two years old). Other trees normally take more than one year in which to form blossom buds on unpruned laterals, and for these trees they should be left unpruned for two successive years. The disposition of trees to form blossom buds on laterals is governed both by vigour and by variety. Young trees of most varieties take more than one year to form blossom buds on laterals while they are making very vigorous growth. The usual exceptions are Fertility, Dorondeau and Beurre Bedford pears and Laxton's Superb, James Grieve, Early Victoria, Lane's Prince Albert, and Lord Derby apples.

Once cropping begins, all the recommended varieties under consideration will usually form blossom buds on laterals by the time they are two years old. Hence the younger and more vigorous a tree the greater will be the tendency to leave even bi-lats unpruned. The degree to which laterals should be shortened, once they have formed blossom buds, again depends on vigour and variety. When only poor or moderate growth has been made, the shortening process should be more severe than when more vigorous growth has been made. Similarly the shortening should be more severe when large fruits are required than in the case of varieties from which fruits of moderate size have the best market value. Having outlined the reasons for varying the treatment of laterals that are two or more years old, the following general recommendations can be made.

Unproductive Trees with Very Vigorous Growth.

No pruning of bi-lats or tri-lats is needed except that needed to eliminate crossing and rubbing and to dispose of those competing with leaders and any that stand very erect (see p. 184). Once blossom buds in quantity have formed on the unpruned laterals, the first pruning should be for the removal of the unproductive maiden wood from the extreme ends.

Productive Trees with Vigorous Growth.

Most varieties that fit in with this classification form blossom buds readily and some shortening of such of their laterals as are more than one year old should be done. Probable exceptions are Doyenne du Comice pear and Miller's Seedling apple, in which cases they should not be shortened until blossom buds have formed on them. In the case of Doyenne du Comice all the blossom buds should be retained and only the maiden wood at the extreme end should be removed. For Miller's Seedling the length of the lateral should be reduced to leave not more than three or four blossom buds.

For pear varieties such as Conference, Laxton's Superb, Williams' bon Chrétien, Dr. Jules Guyot and Clapp's Favourite, and for apple varieties such as Cox's Orange Pippin, Laxton's Superb, Laxton's Fortune, Tydeman's Early Worcester, James Grieve, Ribston Pippin, Lord Lambourne, Sunset and King Edward VII, all of the bi-lats containing the blossom buds should be retained and only the maiden wood at the extreme end should be removed.

The pruning treatment should be rather more severe than in the foregoing with varieties where there is some difficulty in securing fruits of adequate size or in which it is large specimens that have the best market value. Such pear varieties include Fertility, Durondeau and Beurre Bedford and the apple varieties Early Victoria, Grenadier, Lane's Prince Albert, Lord Derby and Crawley Beauty. For these, both bi-lats and tri-lats should be shortened to leave on each only 3–4 blossom buds. The 3–4 blossoms selected should be situated as near to the base of a lateral as practicable.

Productive Trees with Moderate Growth.

Trees that have made moderate growth form blossom buds more readily than vigorous trees, and in consequence a treatment is needed that will prevent any further reduction in vigour. The disposition of a tree to form blossom buds and make a moderate amount of new season's growth is indicative of a satisfactory state of affairs and this is more likely to be maintained by a judicious reduction of blossom buds than by retaining them all. A reduction of blossom buds is necessary not only for the purpose of keeping up vigour, but also to help in maintaining satisfactory size of fruit. In view of this and of the fact that bi-lats for trees of this description are generously furnished with blossom buds, the shortening of all laterals more

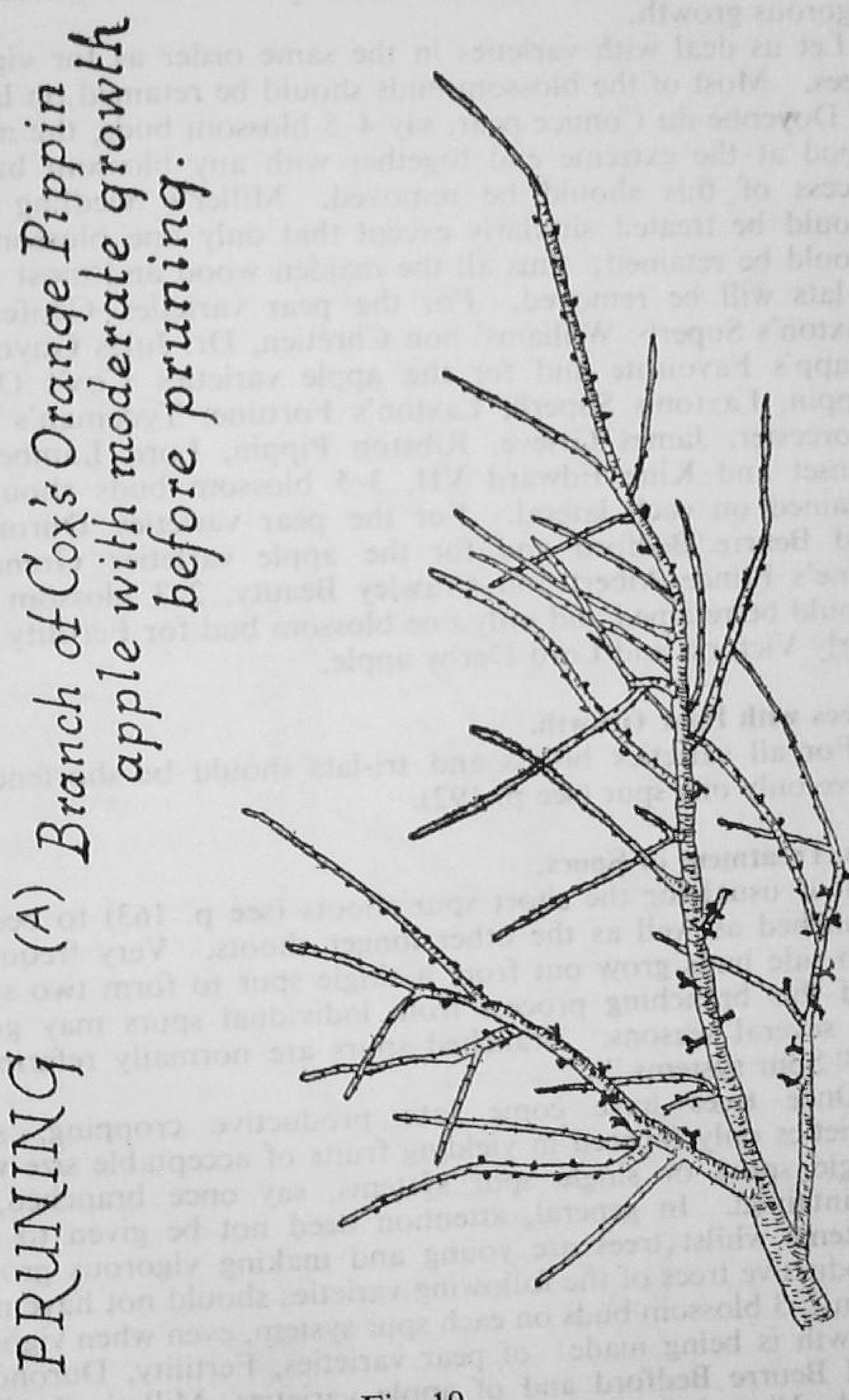
PRUNING (A) Branch of Cox's Orange Pippin
apple with moderate growth
before pruning.

Fig. 19

than one year old should be more drastic than for trees with vigorous growth.

Let us deal with varieties in the same order as for vigorous trees. Most of the blossom buds should be retained on laterals of Doyenne du Comice pear, say 4–5 blossom buds, the maiden wood at the extreme end together with any blossom buds in excess of this should be removed. Miller's Seedling apple should be treated similarly except that only one blossom bud should be retained; thus all the maiden wood and most of the bi-lats will be removed. For the pear varieties Conference, Laxton's Superb, Williams' bon Chrétien, Dr. Jules Guyot and Clapp's Favourite and for the apple varieties Cox's Orange Pippin, Laxton's Superb, Laxton's Fortune, Tydeman's Early Worcester, James Grieve, Ribston Pippin, Lord Lambourne, Sunset and King Edward VII, 3–5 blossom buds should be retained on each lateral. For the pear varieties Durondeau and Beurre Bedford and for the apple varieties Grenadier, Lane's Prince Albert and Crawley Beauty, 2–3 blossom buds should be retained and only one blossom bud for Fertility pear, Early Victoria and Lord Derby apple.

Trees with Poor Growth.

For all varieties bi-lats and tri-lats should be shortened to leave only one spur (see p. 192).

(iv) Treatment of Spurs.

It is usual for the short spur shoots (see p. 163) to become branched as well as the other longer shoots. Very frequently two side buds grow out from a single spur to form two spurs, and this branching process from individual spurs may go on for several seasons. Branched spurs are normally referred to as " Spur systems."

Once trees have come into productive cropping, some varieties only succeed in yielding fruits of acceptable size when single spurs or single spur systems, say once branched, are maintained. In general, attention need not be given to spur systems whilst trees are young and making vigorous growth. Productive trees of the following varieties should not have more than 2–3 blossom buds on each spur system, even when vigorous growth is being made: of pear varieties, Fertility, Durondeau and Beurre Bedford and of apple varieties, Miller's Seedling, Early Victoria, Grenadier, Lord Derby and Crawley Beauty. When the new season's growth is less than moderate for these varieties the spur system should be reduced to leave only single

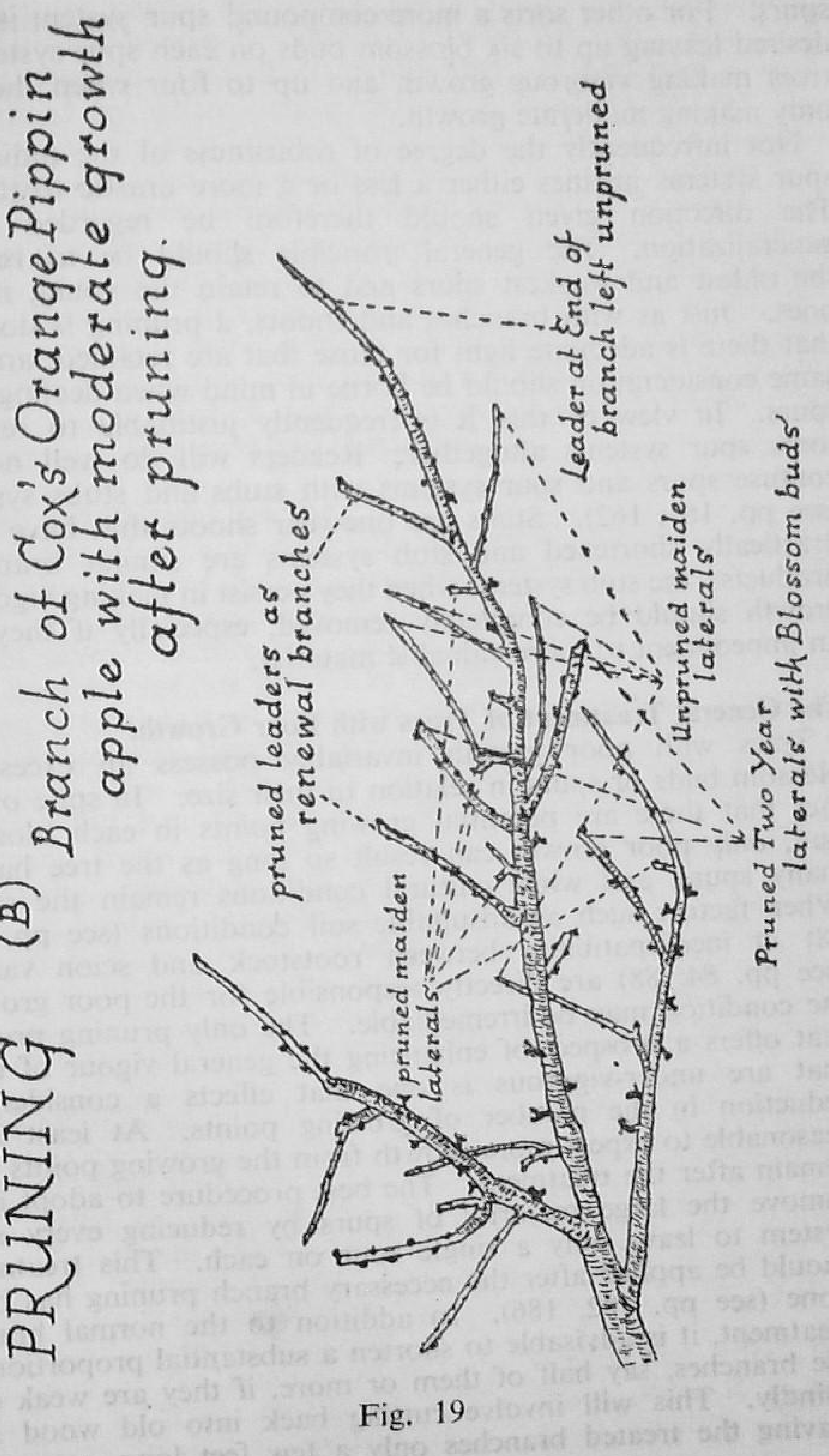
PRUNING (B) Branch of Cox's Orange Pippin
apple with moderate growth
after pruning.
pruned leaders as
renewal branches
Leader at End of
branch left unpruned
pruned maiden
laterals
Unpruned maiden
laterals
Pruned Two Year
laterals with Blossom buds

Fig. 19

spurs. For other sorts a more compound spur system is to be desired leaving up to six blossom buds on each spur system for trees making vigorous growth and up to four when they are only making moderate growth.

Not infrequently the degree of robustness of the individual spur systems justifies either a less or a more drastic treatment. The direction given should therefore be regarded as a generalization. The general principle should be to remove the oldest and weakest spurs and to retain the young robust ones. Just as with branches and shoots, a pruning is done so that there is adequate light for those that are retained, and the same consideration should be borne in mind when dealing with spurs. In view of this it is frequently justifiable to remove some spur systems altogether. Readers will do well not to confuse spurs and spur systems with stubs and stubs systems (see pp. 161, 162). Stubs are one-year shoots that have been drastically shortened and stub systems are similar branched products; the stub systems when they persist in making vigorous growth should be completely removed, especially if they are an impediment to more valuable material.

The General Treatment of Trees with Poor Growth.

Trees with poor growth invariably possess an excess of blossom buds or spurs in relation to their size. In spite of the fact that there are potential growing points in each blossom bud, only poor growth can result so long as the tree has so many spurs, and while cultural conditions remain the same. When factors such as unsuitable soil conditions (see pp. 35–38) or incompatibility between rootstock and scion variety (see pp. 84, 88) are directly responsible for the poor growth, the condition may be irremediable. The only pruning process that offers a prospect of enhancing the general vigour of trees that are under-vigorous is one that effects a considerable reduction in the number of growing points. At least it is reasonable to expect more growth from the growing points that remain after the treatment. The best procedure to adopt is to remove the large majority of spurs by reducing every spur system to leave only a single spur on each. This treatment should be applied after the necessary branch pruning has been done (see pp. 182, 186). In addition to the normal branch treatment, it is advisable to shorten a substantial proportion of the branches, say half of them or more, if they are weak and spindly. This will involve cutting back into old wood and leaving the treated branches only a few feet long, a practice

referred to as partial dehorning (see p. 183). The branches so treated should be evenly dispersed around the tree. The most suitable position at which to remove the top part of a branch is governed by where young growth is most wanted for the development of a new branch. So far as is possible, the shortening should be done at a position where there are existing side shoots or spurs from which subsequent growth can be made. At least the operator should avoid leaving branches bare of a bud, a shoot, or a spur in the near neighbourhood of the cut surface.

The treatment described is a good starting point for encouragement of better growth. Pruning alone, however, will not suffice to maintain such trees in a suitable state of vigour. Lack of vigour must be regarded primarily as a problem to be resolved by cultivations and manuring.

Pruning and Biennial Bearing.

Some varieties, more especially of apples than of pears, tend to yield heavy crops every alternate year rather than good crops annually. This character is spoken of as "Biennial Bearing." One of several factors may induce the biennial bearing habit, or it may be various factors in combination. A Spring frost causing a total loss of crop one year is frequently responsible for the biennial bearing habit of a variety like Bramley's Seedling. This is also true for other notoriously biennial varieties, but even so, they tend towards the habit irrespective of Spring frosts. Profuse blossoming accompanied by good pollinating conditions suffices to carry varieties like Miller's Seedling, Laxton's Superb, Ellison's Orange, Early Victoria and Crawley Beauty, into the biennial habit. The variety Ellison's Orange is included in the foregoing list in view of its pronounced biennial bearing habit and the comparatively large acreage that is grown although it is not one of the recommended varieties (p. 57).

The cause of profuse blossoming may be due to climatological factors at the time blossoms are formed, or to the pruning being less severe than required so that excessive blossom bud formation is permitted, or, again, to lack of vigour due to a relatively low nutritional status. Once established, it is not an easy matter to correct biennial bearing although it is hardly necessary to discuss the advantage of securing regular crops, so far as it is economically possible to do so.

In view of the number of varying factors that affect the behaviour of trees, especially climatological ones, it is not possible to prevent irregularities in crop production. Much

can be done by pruning to control biennial bearing and, needless to say, the treatments are assisted greatly by climatic conditions favourable for blossom bud formation together with suitable nutritional and cultural conditions.

A heavy cropping year is referred to as an " on " year, whereas a light cropping year is referred to as an " off " year. The pruning of trees subject to the biennial bearing habit depends upon whether the treatment is applied after an " off " year or after an " on " year.

The pruning of branches and leaders to give suitable spacing and to eliminate crossing wood will be the same as described above for normal trees after both the " on " and the " off " year.

(i) Pruning after the " Off " Year.

It can be assumed that there will be profuse blossoming in the Spring after an " off " year, and that blossom buds will have been formed by the time of pruning. Pruning should be designed to reduce the quantity of blossom buds and blossom-bearing wood and to retain a large proportion of the non-blossoming wood and this, in most sorts, is the maiden wood. The manner in which blossom buds are reduced depends upon how and where they are borne. They may be borne on old spurs or spur systems, or as young spurs on laterals : also they are frequently borne on one-year wood, especially at the tips. Spur systems should be reduced to leave single-spur units.

A large proportion, say one-half to two-thirds, of the bi-lats and tri-lats furnished with blossom buds should be shortened severely to eliminate their blossom buds. For preference, those that have least non-cropping (i.e. maiden) wood should be chosen for the shortening. In effect they will be shortened to leave them as unproductive stubs about 2–4 inches long (see p. 186). The procedure should differ somewhat with variety. With Miller's Seedling, Crawley Beauty and Early Victoria, sorts with which some difficulty is frequently experienced in securing fruits of acceptable size, laterals furnished with blossom buds should be dealt with on every branch by shortening two of every three and retaining one. For the varieties Ellison's Orange and Laxton's Superb, sorts which are liable to yield fruits excessively large for dessert if the pruning is drastic over the entire tree, treatment should be confined to one-half of each tree by completely eliminating the blossoms from alternate branches. Thus for one branch all the blossom bearing laterals will be retained, and from the neighbouring branch all will be shortened to leave them as short stubs.

In addition to the process of reducing blossom buds by their removal together with the wood upon which they are borne, others should be removed by dealing only with the buds. In Miller's Seedling, Crawley Beauty and Early Victoria, two out of every three of the blossom buds that remain should be removed. The method of removal may be either by cutting out the flower trusses during Spring or by pushing the buds out during Winter, this latter method is referred to as "bud rubbing." Since for Laxton's Superb and Ellison's Orange it is advised that every alternate branch should be entirely deprived of blossom buds, all spur blossoms on the treated branches should be removed by the bud-rubbing or blossom thinning method.

As little as possible of the maiden wood should be pruned away after an "off" year. For most varieties it is possible to depend upon this wood to yield only leaves during the "on" year. Thus the prospect of blossom buds being formed on it during the "on" year is good, provided good leaves are formed. The blossom buds formed are the only hope of crop during the normal "off" year. Unfortunately the varieties Laxton's Superb and Ellison's Orange are prone to blossom and fruit on one-year-old wood. When this occurs it is necessary, in Spring, to remove the blossom trusses from them, either with scissors or a knife. One year shoots that have several blossom buds on them should be shortened so that the blossoms are eliminated. At times, short maiden shoots are terminated by a blossom bud; such tip blossom buds should be removed during the Winter pruning. The pruning of sorts that blossom profusely on the one year wood is rendered less laborious if it is deferred until blossom buds can be readily distinguished.

In effect, the single aim of the treatments outlined is to secure a relatively high leaf surface during an "on" year, in relation to the amount of blossom carried. This is done in the hope that this enhanced ratio of leaves to blossom buds will suffice to enable the leaves to participate in the formation of blossom buds while a crop of fruit is being borne.

In the event of a larger surface than usual of one-year wood being left on the tree, a small increase in Nitrogen manuring is advisable; moreover, a sunny June is an invaluable help to the achievement of the end in view.

(ii) Pruning after the "On" Year.

After a heavy crop has been carried and the appearance of the buds shows that little or no crop is likely to be borne the

next Summer, it will be appreciated that nothing can be done during the Winter to alter this. All that can be done is to prevent an excessive number of blossom buds from being formed during the Summer of the " off " year and to provide the necessary stimulus for a plentiful supply of young shoots.

The spur systems should be kept simple by reducing them, so as to leave each with a single spur. All tri-lats and two-thirds of the maiden laterals and bi-lats should be shortened to leave them as short stubs about 2 inches long. In addition to this, it is advisable to shorten drastically, that is to dehorn, three to four of the branches by cutting back into four or five year old wood.

Sometimes the first corrective treatment will be given after an " off " year, and sometimes after an " on " year. When it is after the " off " year, care should be taken at the time of the next pruning not to dehorn branches that were totally de-blossomed the previous year and also to remove only maiden wood from the bi-lats. When the start is made after an " on " year, no bi-lats need be shortened or eliminated at the ensuing pruning, except in varieties whose alternate branches are deprived of blossom buds. Once a satisfactory degree of correction is obtained, the pruning as advised for normal trees should be followed (see pp. 182–193).

SUMMARY OF TREATMENT.

Apples, Pears, Plums, Damsons and Cherries. (For trees planted at wide distances).

Whether or not to Prune During the Season of Planting.

Prune when there is good reason to expect good growth; otherwise leave unpruned.

Forming the Head.

For the single-stemmed tree, remove the top at 6–8 inches higher than the position at which the lowest branches should occur. For bush and half-standard trees, remove any side shoots which are too low to form branches; for standard trees, leave as stubs 3–4 inches long for one year, and then remove them altogether.

For feathered trees, the feather is removed if it is all on one side and if there is only a single feather, prune such trees as for the single stemmed tree. Remove central stem when there are three feathers, or more, suitable to form branches. Shorten central stem as in single stemmed trees when only two suitable feathers are present.

Three to five shoots are wanted to form the initial head. Remove the least suitable shoots when they exceed five in number. Erect shoots should not be employed for branches, especially in the case of named plum varieties (see p. 177). Branch-forming shoots should not overlap and shade one another.

When only two shoots are formed, shorten both drastically; the more erect one shorten to leave the tree 3 inches taller than in the previous season. Shorten selected branch-forming shoots to form a balanced head. When poor growth is made on one side of a tree " notch " the stem, directly above the weak shoots.

Remove flower trusses from trees with poor growth.

Remove from one-third to two-thirds of each leader from trees with good growth, leaving the tips of pruned shoots at least 9 inches apart. With three leaders of equal vigour, prune them to leave them equal lengths. With four or five leaders, prune two of them more severely than the remainder.

The Subsequent Pruning Treatment of :—

Apples (sturdy wooded sorts).

Pears (vigorous Doyenne du Comice).

Cherries, Plums and Damsons.

(*i*) *General Treatment.*

Remove or shorten branches and shoots to eliminate rubbing and take out those with insufficient space. Remove branches that are very erect, or shorten them to outwardly growing side-branches or shoots.

(*ii*) *Treatment of Leaders.*

Where there is insufficient young growth, shorten all leaders in trees with two-year-old heads and in older trees, following the same principle as for trees with one year heads. Shorten by one-third to one-half every alternate leader of trees with two-year-old heads with good young growth. After this discontinue systematic leader tipping except for a few shoots each year to replace spreading branches.

The Subsequent Pruning Treatment of :—

Apples (excepting sturdy wooded sorts).

Pears (excepting vigorous Doyenne du Comice).

(*i*) *Treatment of Branches.*

Remove or shorten to outward growing side branches or shoots, central erect branches. Remove or shorten a

branch when: (*a*) Two branches rub or nearly rub, (*b*) Two branches overlap and are nearer to one another than 2 feet, (*c*) Two branches lying side by side nearer to one another than 18 inches, (*d*) Branches directed towards the centre and the side of a tree opposite the parent branch, (*e*) Branches too low for cultivations. For trees failing to make sufficient young growth, " partial de-horning " should be practised.

(*ii*) *Treatment of Leaders.*

Shorten leaders to extend branches not tall enough, at positions where new leaders and laterals are required. Space to have them at least 18 inches apart at positions of pruning. Shorten a few shoots selected as replacement leaders, on branches that are long enough and not pruned at the extreme ends.

In trees making vigorous growth, only shorten alternate leaders.

In varieties inclined to yield bare wood (see p. 184), long leaders should either be shortened or buds on them notched.

(*iii*) *Treatment of Side Shoots.*

Remove vigorous erect laterals.

(*a*) *Maiden Laterals.* Remove any maiden laterals that cause excessive shade and one of any two that are crossing or rubbing at positions near the base, otherwise leave all unpruned for very vigorous trees.

In trees with vigorous and moderate growth, shorten a proportion of maiden laterals to short stubs 2–3 inches long and leave the remainder unpruned. The proportions should differ according to variety (see pp. 185–186).

For trees with poor growth, leave all laterals unpruned save for removing tip buds when terminated by blossom buds.

(*b*) *Bi-lats and Tri-lats.* Shorten bi-lats and tri-lats, once they are furnished with blossom buds. The degree of shortening that should be done depends upon vigour and variety (see pp. 187–190).

(*iv*) *Treatment of Spurs.*

Reduce spurs, selecting for the purpose the oldest and weakest; the degree of reduction will depend upon number of spurs on spur systems, upon vigour and upon variety (see p. 190).

The General Treatment of Trees with Poor Growth.

Reduce spur systems to leave a single spur on each. Partially dehorn (50 per cent. or more) of the branches, other branch treatment to be the same as for normal trees.

Pruning and Biennial Bearing.

Prune as with normal trees to give suitable spacing of material.

(*i*) *Pruning After the "Off" Year.*

When no previous treatment after an "on" year has been given, reduce spur systems to leave a single spur on each. Shorten one-half to two-thirds of the bi-lats and tri-lats to leave them as short unproductive stubs. The alternate branch method should be followed for the varieties Laxton's Superb and Ellison's Orange. Bud-rub two of every three blossom buds of the varieties Miller's Seedling, Early Victoria and Crawley Beauty. Strip blossoms by bud-rubbing alternate branches of the varieties Laxton's Superb and Ellison's Orange also remove blossom buds occurring on one-year-old wood at the time of blossoming.

(*ii*) *Pruning After the "On" Year.*

Reduce spur systems to leave a single spur on each. Shorten two-thirds of the one-year laterals to leave them as short stubs 2 inches long. Partially dehorn three or four branches in each tree. If no previous treatment has been given after the "off" year, shorten to leave as unproductive stubs, all bi-lats and tri-lats. When treatment has been given, only shorten tri-lats and remove maiden wood from bi-lats.

CHAPTER VIII

SPRAYING SYSTEMS AND APPLIANCES

The fruit growing enterprise needs suitable provision for spraying. Equipment for this purpose is not uniform and a grower must choose the particular form, or system, that will suit his needs best. The considerations affecting this choice are discussed and the principal systems and appliances are briefly described.

From the time that fruit crops are planted until the time they are dispensed with, the occurrence of various pests and diseases must be prevented or kept under reasonable control in order to secure suitable growth and to render the production of economic crops possible. Pests and diseases of economic significance cannot all be resolved by the one and the same method, but spraying is the most satisfactory method of dealing with the majority.

It is a relatively simple matter to spray a few small trees or bushes in a private garden with a knapsack sprayer or a hand operated bucket sprayer. This method is not applicable to commercial enterprises after the first season or two, because many acres have to be sprayed, in some cases several times during the year. Each spray must be applied within a given period, and although the period permissible is longer for some sprays than for others, it is those that must be applied within the shortest period over the greatest acreage and in the greatest quantity, that determine the nature of the equipment required.

It should be possible to spray the total acreage devoted to apples and pears within five working days, and this can be extended say to 10 days when the acreage is further split up to include cherries and plums. Where fully established trees and bushes are concerned, it is clear that a large quantity of spray fluid must be applied during the course of a single day's spraying. From this it follows that specific requirements, such as adequate water supply with a pumping outfit capable of discharging an adequate amount of spray fluid in a given time

with sufficient force and a labour gang in sufficient strength both to apply the spray and attend to the details of the operation are needed. However, there are several factors that tend to reduce the time actually available for spraying. Unsuitable weather, operational delays caused by breakdowns, refilling, moving from one tree to another, and the dragging of hose pipes or moving machine into positions of operational advantage all reduce spraying time. The different spraying systems account in different ways for reductions in the actual time spent spraying per day. In one case, reduction may be due to changing over from spraying one group of trees to another; in other instances it may be due to the frequent refilling of the tanks attached to the spraying machine (especially when there are no supply links between the source of water and different parts of an orchard). It is wise to assume that not more than one-half of a working day will be spent as actual spraying time. This is important when calculating the output in terms of gallons required from a spraying plant over a given period.

The selection of a suitable spraying plant is in the first place determined by the performance required, and the performance required is calculated by the output of spray that is needed at working pressures of 300–500 lb. per square inch, during the number of spraying hours provided by five working days. The calculation should not be based on current requirements but on what is likely to be necessary in five years time. For the newly planted fruit farm, for which very small quantities indeed of spray are needed as compared with those for established orchards, temporary low-powered spray machines should be employed for the first four or five years. Many growers start off by spraying their trees before they are planted and follow up for the next one or two years with a hand sprayer. After this, and for the next two to four years, a low powered outfit is necessary. Once this initial period has passed, equipment capable of supplying the maximum output will be required to spray the fully established trees within the specified period. The most economical time to change over from temporary to permanent equipment depends upon the acreage of the respective crops. Most bush fruits are fully established by the time they are six years old, and tree fruits by the time they are twelve years old, with the exception of large growing trees such as Bramley's Seedling apples and sweet cherries, which take about fifteen to twenty years.

Assuming that a grower has 60 acres of tree fruit that will need spraying within five working days at a rate of 300 gallons

per acre, and that these requirements are likely to remain for several years, he will require plant capable of discharging 15 gallons per minute at 300–500 lb. pressure per square inch, because each working day will provide an average of four spraying hours, so that there are 20 spraying hours available in a five day week, in which the 18,000 gallons of spray required will be discharged.

The output of a spraying plant is normally shared by two or more operators engaged in the actual application. Each operator can put to effective use (depending on the size of the trees), from 3 to 10 gallons of spray per minute. The larger the trees the greater will be the quantity of spray that one man can employ effectively. Obviously the number of spraying hands that can be put to best use is governed by the output of spray that can be maintained at the required pressure by the spraying plant, and by the size of the trees. A larger number of hands does not necessarily increase the speed of the operation or the general efficiency of the job, because the output of a machine cannot be increased beyond its capacity, and by increasing the number of operators beyond a certain figure, the amount of spray supplied to each is reduced.

CHOICE OF SYSTEM.

There are two spraying systems that demand serious consideration with a possible third where soft fruit is concerned and to a limited extent for tree fruit. The systems are conveniently referred to as: (i) Underground Mains, (ii) Mobile, (iii) Portable Mains.

(i) Underground Mains System.

This consists of an underground steel-pipe system (i.e. mains and laterals), for preference Security Wrapped piping, permanently connected up to a stationary pumping plant. Sometimes, but rarely, the pipes are connected to a portable plant at the time of usage. The stationary pumping plant is normally housed under cover, located where there is an adequate and suitable water supply, easily accessible for the reception of spray materials, and provided with facilities for their storage. In addition to this, in view of the fact that spray materials have to be diluted from a concentrated form to the strength most suitable for the control of specific pests and diseases, facilities are necessary both for mixing and for holding the diluted spray in quantity. A large tank is necessary for each purpose. The spray is drawn into the pumps by suction and thence

discharged under pressure through the mains. The concentrate, except when powders are concerned, is usually run off from a small graduated tank into the large mixing tank designed to hold a measured quantity of wash. The tanks can be arranged so that the concentrate flows by gravity into the mixing tank and from the mixing tank into the tank from which the pumps draw the diluted wash. Thus it is possible to avoid delays by having a supply of wash mixed in advance of actual requirements.

At regular intervals, in each orchard served with spray mains are spraying points, or standpipes as they are termed, each fitted with a stop cock and provided with facilities for attachment of a length of rubber hose terminated by a spray lance or gun (see p. 207). The spray lances or guns are man operated. In this way each standpipe normally suffices to spray trees covering about a quarter of an acre.

There are certain unquestionable advantages of the underground mains system over other systems. The most economical method of conveying a fluid in quantity for several successive years is through a permanent pipe. Furthermore, it eliminates certain physical difficulties attending the mobile system. A fixed point for the collection, mixing and discharge of sprays entails less labour and transport than systems requiring several points for these purposes. The number of possible spraying days is greater than for systems which involve the haulage of heavy tackle, especially where arable conditions and steep gradients are concerned. Not only does the state of the soil have to be reckoned with, but there is also the liability of operational breakdowns to be faced. Furthermore, wear and tear of equipment is lowest for the underground mains system and the spraying is independent of a tractor. The initial capital outlay is greater for this system than for others, but this is offset by the fact that operational costs are lower. It must be allowed that leakages, when they occur, are troublesome to contend with, but if good mains are installed in a competent manner, leakages are not likely to occur for several years after installation. Obviously the system is not readily adapted to the needs of some farms, for instance where short term soft fruit crops predominate, or where a farm has scattered orchard units.

There is no reason why individual orchard units should not have underground mains, without connection to a permanent stationary pumping plant. Such mains can be served by a portable or mobile machine that can be moved and connected to each unit in turn. The chief disadvantage of the underground mains system, leaving out of account the difficulty of

dealing with burst pipes, is the burden of dragging long hose pipes. Stand pipe valve leakages and sedimentation in mains are further difficulties to contend with.

(ii) Mobile System.

In this system, the spraying is done direct from the spraying plant usually with the aid of short length hoses fitted with spray lances or guns. The spraying plant is towed from tree to tree between the tree rows, and is specially constructed and fitted with pneumatic wheels for the purpose. A tank to hold a quantity of diluted spray, say 250 gallons is an essential part of a mobile plant. The spray lances or guns are usually man operated and for bushes and small sized trees continuous movement, giving complete mobility, is possible, in which case the spray operators can frequently ride on a platform provided at the rear of the machine. With large sized trees, each of which consumes a considerable quantity of spray, it is necessary to pause at each tree to allow time for the spraying to be completed. The mobile sprayer is normally towed by tractor, and whereas one may be fitted with an independent engine for driving the pumps, others depend upon the tractor engine by which the pumps are driven through the agency of a power-take-off.

For established fruit trees, a mobile sprayer fitted with a 250 gal. tank is capable of carrying sufficient spray for one-sixth of an acre to one acre. It is necessary to adopt one of two methods for refilling, either the diluted spray must be conveyed to the spraying plant or the spraying plant must return to established filling bases. Obviously such bases must be established in reasonable proximity to the scene of operations, because the greater the distance the greater the delay in completing the spraying operation. This is a very important consideration, especially for fruits that consume considerable quantities of spray and require spraying, maybe seven times during the course of a year.

The advantages of the mobile system are: (i) The initial capital outlay is appreciably less, say less than one-half, than that for the underground mains system, (ii) Trouble due to faulty valves and pipe leakages are practically eliminated, (iii) Long hoses do not have to be dragged by the operators. The system is most suited for relatively flat conditions, for short term crops such as soft fruits, for grass orcharding, especially in the case of cherries and plums, which require fewer sprayings per annum than apples. It must be pointed out that the

operational costs are rather high, due to transport of water, the employment of a tractor and heavy wear and tear.

(iii) Portable Mains System.

The plant required is not dissimilar from that needed for the mobile system, because it consists of pump, engine and tank mounted on wheels so that it can be drawn to pre-determined positions in an orchard. From thence the pumping of spray fluid proceeds. In fact, a mobile plant is interchangeable and can be employed either as a mobile or as a portable mains system. The spraying plant remains stationary whilst spraying is in progress and is connected with overland mains (i.e. pipes) which must be assembled for each spraying operation and dismantled upon its completion. The pipes consist of short-steel pipes with flexible connections. The spraying is done from spray guns or lances, each of which is attached to a length of hose and connected with the spray mains. When spraying is done with the aid of portable mains, an orchard is dealt with on a sectional basis. Once a section has been sprayed, the spraying plant is then connected to mains in readiness for dealing with the next section. In order to cut down operational delays to a minimum, there should be two sets of mains, so that one set is in process of being assembled whilst the other is being used for the actual spraying.

Although some growers adopt this system throughout, it is less satisfactory than the other two systems previously outlined. For soft fruits, that do not permit the easy passage of a mobile plant (although nowadays planting systems should be adopted that do allow for easy passage); for fruit where the gradient and soil induce conditions unsuitable for mobile spraying, also for orchards unsuitable for the mobile operation and do not require spraying often enough to justify the high capital outlay upon underground mains, there is something to be said for the system. In general, the portable mains system has its highest value when used as an auxiliary to an underground mains system or to a mobile system. When portable mains are employed as an auxiliary to the underground mains system, it is possible to connect to an underground mains standpipe and the spray can then be discharged from the stationary pumping plant.

There are several disadvantages to the portable mains system. Not only has the constantly recurring charge of assembling and dismantling the mains to be met, but leakages are very liable to follow the frequent screwing and unscrewing of the pipes. The

double considerations of increased labour costs and a general lower standard of efficiency do not commend the system for general acceptance. Arrangements for maintaining water supply are of a similar nature to those for the mobile system, although they may not be so exacting. It should be pointed out that the capital outlay for this system is rather greater than that for the mobile system.

The real test when comparing the relative merits of the various spraying systems is the total expenditure incurred for the maintenance of efficient pest and disease control. Given suitable, but otherwise comparable, conditions it is to be doubted whether there is anything to choose between the mobile and underground mains systems. There are circumstances under which considerable advantage lies with the underground mains system, although with the mobile system the operation is becoming increasingly mechanised, and this should further popularize it for relatively flat ground where bush trees are being dealt with on the wide row, close tree, plant (see p. 53). Nevertheless efficient and economical spraying is not, at the present time, solely dependent upon the choice of a system; it is to an even greater extent dependent upon the equipment at one's disposal. In the first place, a spraying plant must be capable of supplying an adequate output of spray with sufficient force and in the required time (see p. 201). In the second place, auxiliary equipment in the nature of hoses, lances or guns, taps, valves, nozzles, swirl plates and discs (i.e. small circular plates supplying an aperture at the end of the spray nozzle) are of fundamental importance.

Hoses.

Since spraying has to be done at distances from a spraying machine or from the mains, it is necessary to connect hoses to them through which the spray fluid passes to the spray lances or guns from which the spray is discharged. By dragging flexible hoses into positions, it is possible for an operator to pass from tree to tree, and round each tree, in order to apply the spray. Hoses are either attached to the spraying plant, in a case in which the mobile system is adopted, or to the mains. In the case of the underground mains, standpipes provide the fixture points (see p. 203). Hoses should be of a quality suitable to withstand high pressures and oily sprays, it is also advisable to have spares in addition to those required for operational purposes. The length of an individual hose, when attached to mains, is usually 120 feet; and when attached to a mobile

spraying outfit, 60 feet. When the output of spray is not more than 6 gal. per minute, hoses with an internal diameter of ½-inch should be used; whereas for greater outputs than this, hose with an internal diameter of ¾-inch is needed. Obviously the connections of hoses to mains, spraying plants, lances and guns should be such as to withstand high pressures.

Spray Lances and Guns.

Some years ago, slender pipes or rods terminating with a single spray nozzle and spoken of as spray lances were the principal means of applying sprays. At that time bush trees were less in prominence than half-standards and standards, and therefore long lances were required to give high reach; this was because the spraying plants only supplied small outputs at low pressure. With the advent of spraying plants that give big outputs at high pressure, shorter lances, 2–4 feet long, and the so-called spray gun came into favour. Modern spraying plants have rendered possible the employment of instruments demanding less physical exertion than that demanded by the long lance, and at the same time the speed of the operation has been accelerated.

The principal distinguishing feature between the spray lance and the spray gun is that with the spray gun, changes in the form of spray can be made as the spraying proceeds, whereas with the spray lance the nature of the spray is constant, or fixed, and adjustments can only be made whilst the equipment is at rest. The forms of adjustment possible are changes of discs with larger or smaller apertures, the changing of swirl plates with several holes or with few holes. In some types of lance, the angle at which the nozzle is held can be varied. With the spray gun, operational adjustment of the form of spray from the long carrying narrow spray to the short wide spray can be made by turning a knob at the base of the gun, and this alters the depth of orifice in the eddy chamber through which the spray flows on its passage through the nozzle.

It should be pointed out that in the eddy chamber it is usual to have a " swirl " plate, designed to give a swirling motion to the spray. A seven-hole swirl plate is used when a broader type of spray with less carry is wanted. For a coarser spray with greater carry a three-hole swirl plate is used, having one large central hole and two smaller holes, one on each side.

Where small or moderate sized trees are being dealt with, there may be little to choose between the short lance and the gun, but where tall trees, or trees of extreme variability, are

being dealt with, the spray gun is favoured. It will be appreciated that with anything but small, very young trees neither the lance nor the gun is satisfactory in the absence of adequate output or pressure.

Nozzles.

Of the various forms of spray nozzles available, modifications of the original Vermorel type are favoured. Two main decisions have to be made about nozzles, viz. the number there should be per lance or gun, and whether they should be of the fixed or adjustable type. There may be only one, or as many as four, nozzles per lance or gun. What is best for one set of conditions may be unsuitable for another, since the matter is determined by the plant material to be sprayed, whether trees to be treated are large, small, or intermediate; what output is available per lance or gun, whether few or several gallons per minute are to be maintained at the required pressure. The most economical output per nozzle is reputed to be in the region of 3 gallons per minute; thus when large but not tall trees, requiring a big gallonage of spray, are being dealt with by a plant capable of supplying 30 to 40 gallons per minute at 400 lb. pressure to the square inch, the multiple nozzle lance or gun is best. In such cases, three or four four-nozzle lances could be employed with good effect. For smaller sized trees, and for large sized bushes, two and three nozzles are more economical and satisfactory units to employ; and in this case the number of operators can be increased to consume the available output. For very small trees and bushes, single-nozzle units operating under relatively low pressure, say 150–250 lb. per square inch, are most likely to give best value. A grower should become familiar with the basis of calculation as to the most efficient number of nozzles per man and per spraying plant for given types of material.

Discs.

A spray-nozzle is terminated by an orifice of suitable dimensions through which the spray is discharged. The orifice is usually supplied by a single hole in the centre of a small circular piece of metal, commonly referred to as a " disc." The diameters of the orifices differ according to the size numbers of discs. There are several size numbers which increase in stages of $\frac{1}{64}$ of an inch; thus size No. 1 is for an orifice diameter of $\frac{1}{64}$ of an inch, No. 2, $\frac{2}{64}$ of an inch, No. 3, $\frac{3}{64}$ of an inch, and so on.

The employment of high-pressure sprayers and the increasing need for labour economy have led to increased output of spray, and an increased discharge rate per operator. This has led to the employment of larger sized discs in addition to the multiple nozzle lances and guns. Disc Nos. 4, 5, 6 and 7 are the ones most commonly employed. In general, for the taller trees, needing as they do a large gallonage with long carry, the larger sized discs will be needed. Nozzles with discs less than $\frac{4}{64}$ of an inch in diameter are not now advised for general use in view o the increased tendencies for operational delays due to blockages.

Taps.

The greatest item of cost in spraying more often than not goes to materials and not to labour as is often supposed. In view of this, all unnecessary wastage of materials should be avoided. Lances and guns should be supplied with efficient quick acting shut-off taps of the trigger or quick turn type. Furthermore, a constant eye must be kept upon standpipes serving the underground main system, since the valves frequently give trouble and this may cause considerable wastage of materials.

CHAPTER IX

THE PRINCIPAL PESTS AND DISEASES AND CONTROL TREATMENTS

Having gained some knowledge concerning spray equipment, the next step is to consider the range of pests and diseases of commercial significance and the spray programme necessary to deal with them. In this chapter the reader is introduced to the principal pests and diseases of the various fruits and the control treatments.

It is proposed to deal only with pests and diseases of general economic importance against which routine preventative or control measures are necessary. The various fruits are dealt with below and a brief description is given of the nature, form of injury, time of occurrence of each specified pest and disease; together with recommendations for prevention or control. It is essential that fruit growers should know the names of the principal spray materials that are employed for pest and disease control. A note on these materials is given in Appendix 6.

SOFT FRUITS.

1. BLACKCURRANTS.

Aphides or Greenfly.

There are several species that attack the blackcurrant, but all are controlled by the same measure. Wingless aphides feed on newly formed leaves at the tips of the shoots causing much buckling and severe curling of the leaves.

Considerable defoliation results from a severe aphis infestation and in consequence shoot growth is much checked, and fruit size and crop weights are much reduced.

These aphide pests are controlled by spraying either with a 5 per cent. Tar Distillate wash during December to February or an 8 per cent. D.N.O.C., during January to February. The latter spray is advised when currant Capsid Bug is troublesome (see p. 211). Nicotine should be employed at 8 ozs. per 100

gal. water, plus spreader when Winter spraying has been omitted. A Nicotine spray should be applied before the leaves have commenced to curl and it may be effectively combined with a Lime Sulphur spray employed in the control of Big Bud (see below).

Green Capsid Bug.

The young bugs feed on the tender foliage and shoots which they puncture and in doing so cause characteristic brown spots. Upon subsequent expansion, affected leaves have a punctured appearance with most of the injury occurring near the main veins, especially the mid-rib. Not infrequently terminal growing points and leaves are killed by capsid attacks, other leaves have a lacerated appearance and scars are usually visible on the young stems. Feeding continues during the Spring, after which the bugs migrate to various herbaceous plants such as potato and dead nettle. Adult capsids return to the blackcurrant during Autumn to lay eggs.

The Green Capsid Bug is controlled by spraying with a D.N.O.C. wash during January to February at an 8 per cent. concentration. When a D.N.O.C. spray is omitted, a Nicotine spray at 8 ozs. per 100 gal. of water plus spreader should be included in the Lime Sulphur spray designed to control Big Bud. (see below). After this, the application of one or more Nicotine dusts may be very beneficial, the number to be made will depend upon the severity of an attack. D.D.T. is likely to replace Nicotine in the control of Capsid and this could be used at a 0.1 per cent. concentration (see p. 229) with the Lime Sulphur, Big Bud spray (see below); even at this stage, D.D.T. is likely to reduce the severity of Leaf Curling Midge.

Big Bud or Blackcurrant Gall Mite.

Large numbers of mites too small to be seen by the naked eye invade blackcurrant buds, causing them to swell to an abnormal size. Mites migrate during Spring at the time that buds are bursting into leaf and eggs are laid by them inside the buds during the Summer. Young mites feed on bud tissues and this results in a gall formation.

Big Bud is controlled by annual sprayings of Lime Sulphur at the time that blossom buds can be seen, but whilst they are still in the "bunched" or "grape" stage of development, which is before the blossom stalk has elongated to form the raceme. This stage usually occurs between the last two weeks of March and the first week of April. When there is evidence

of a considerable number of swollen buds, the Lime Sulphur should be used at a 5 per cent. concentration. For routine spraying, a 2 per cent. concentration suffices to maintain a satisfactory control. Furthermore, for sulphur sensitive varieties, e.g. Davison's Eight, Lime Sulphur should not be used at more than the 2 per cent. concentration under any circumstances in view of the injury that results. The varieties recommended for planting (p. 56) exhibit a marked degree of sulphur tolerance.

Big Bud is frequently more evident on bushes that have become " reverted " (see below) and a control of mite on such bushes is extremely difficult to obtain. The question of a more efficient control does not arise in view of the fact that it is necessary to eliminate " reverted " bushes.

Leaf Spot.

This fungous disease causes small dark brown angular spots to appear on the foliage from late June onwards; they occur first on the oldest leaves at the base of the bush and proceed thence upwards. When infection is severe, it results in the death of leaves and premature defoliation of bushes, and this in turn results in impaired vigour and reduced crops. Re-infection takes place from old infected leaves on which the fungus matures and overwinters.

Bordeaux mixture at 8 : 8(12) : 100 (see p. 290) or Bordeaux paste 15 lb. per 100 gal. water, applied directly after harvesting the crop, is the recommended control treatment. In severe cases, considerable defoliation may have taken place by this time making it advisable to spray next Spring directly after blossoming: spraying must not be done between this period and harvesting or the copper deposit would be retained by the fruit. For non-fruiting bushes, both in the nursery and those newly planted, spraying should be done during early June. Failing spraying, an annual application of Copper Lime Dust helps to hold the disease in check. The application of a Bordeaux spray is also of value in controlling CURRANT RUST which is especially liable to occur when bushes are grown in close proximity to Five-Needled Pine trees.

Reversion.

This is classed as a virus disease and is probably transmitted by Big Bud mites, Aphides and Capsids that have previously fed on infected bushes. The disease finally results in bushes becoming unproductive, save for a few small fruits, in spite of

profuse blossoming. In addition to this, the appearance of foliage and blossoms on reverted bushes is distinct from that of healthy ones; and this suffices to provide diagnostic symptoms right from the early stages of infection. The blossom buds of healthy shoots are covered with a dense whitish down (pubescence) giving them a whitish brown appearance in the bud stage of development. The blossom buds of reverted shoots have much less pubescence and are of a bold chocolate brown colour. Similarly the young shoots and newly unfolding leaves of healthy bushes are densely covered with a whitish "down-like" pubescence, giving them a soft, whitish green appearance; whereas on reverted bushes they have a bolder, more clearly defined brighter green colour. These symptoms are valuable for diagnosis early in the season in fruiting plantations before Lime Sulphur spraying against Big Bud (see p. 211).

It would seem that this disease disturbs the normal functioning of the vascular system from the fact that the number of veins in the leaves suffers rapid reduction from year to year and in consequence leaf shape is affected. Leaves on reverted bushes are thicker, narrower, flatter at the base and have fewer, but coarser marginal serrations. Leaves on healthy bushes are broad, usually deeply indented at the base (i.e. at the junction with the petiole) and have numerous saw-like marginal teeth. A healthy leaf has two lobes on each side of the main central lobe making five in all, and each lobe is served by a main vein. An examination of the central lobe, reveals that there are five or more lateral veins on each side of the mid-rib. Leaves from reverted bushes have less than five lateral veins on each side of the central lobe and the number of lobes is also reduced in advanced stages.

The only satisfactory control measure is to eliminate all reverted bushes each season, both in the nursery and in established plantations. It need hardly be pointed out that only healthy bushes should be employed for the purpose of propagation. Bushes that are brought in from outside sources should be purchased under a Ministry of Agriculture Certificate, testifying to the fact that they have been inspected and approved. The efficient control of Aphides, Capsid and Big Bud play an important part in keeping down the incidence of Reversion.

SUMMARY OF ROUTINE PEST- AND DISEASE-CONTROL TREATMENTS.

Pests and Diseases.	Treatment.	Period.
Aphides and Capsid.	8% D.N.O.C. spray.	January and February.
Reversion.	Rogueing.	April and July.
Big Bud Mite.	2–5% Lime Sulphur spray.	Early April, i.e. in Bud Flower Stage.
Leaf Spot.	8 : 8 (12) : 100 Bordeaux or 15 lb. Bordeaux Paste + 100 gal. water.	July and August.

2. RED CURRANTS.

Aphides.
Green Capsid Bug.
Leaf Spot.
} See Blackcurrants, pp. 210, 212.

3. GOOSEBERRIES.

Aphides.

The young wingless aphides feed on young leaves and tender shoots causing much curling and deformity.

Control measures against this pest are the same as for Currant Aphis, viz. Tar Oil at 5 per cent. concentration during the dormant season or D.N.O.C. at 8 per cent. during January to February or an early Spring Nicotine spray at 5 to 8 oz. per 100 gal. of water plus spreader or soft soap.

Green Capsid Bug. See Blackcurrant, p. 211.

American Gooseberry Mildew.

In moist, humid situations, this disease is often serious and difficult to control. It is usually first apparent as white powdery patches on the young unfolding leaves; under weather conditions favourable to it, the disease spreads very rapidly from spores produced. White fungal threads are formed on berries and on young shoots and these turn brown, forming a felt-like covering. Small black spots, which are spore cases, are apparent on infected shoots in which the fungus overwinters and from which ascospores are discharged during Spring, causing the leaf infection referred to above.

For gooseberry varieties tolerant of Lime Sulphur, the usual control measure is to apply two sprays of 1 gal. Lime Sulphur to 60 gal. water. The first spray should be applied before the flowers open, but when blossom buds can be seen; and the

second soon after the young developing fruitlets begin to swell. All varieties in the list of recommended sorts (p. 56), with the exception of Leveller, are sulphur tolerant if applied during dull weather conditions. An alternative spray to Lime Sulphur and one to be employed for Sulphur sensitive sorts, is Washing Soda and Soft Soap applied at the rate of 20 lb. Washing Soda, 10 lb. Soft Soap to 100 gal. water. The Soda deposit is readily removed by rain and more frequent sprayings may be necessary than the two advised when Lime Sulphur is employed.

The first Mildew spray may be combined with the Nicotine spray advised for the control of aphis, when no Winter control treatment has been applied.

Sawfly.

It is not uncommon to see bushes defoliated except for the leaf stalks and the coarser veins, as a result of the ravages of the Sawfly caterpillar. There are three generations of this pest during the course of the Spring and Summer months and these occur during April–May, June and August. When fully fed, the caterpillars of the third generation spend the Winter in a cocoon in the soil.

This pest is readily controlled by the application of a Derris or Lonchocarpus dust. Application of the dust as soon as young caterpillars are present is essential.

Leaf Spot. See Blackcurrants, p. 212.

SUMMARY OF ROUTINE PEST- AND DISEASE-CONTROL TREATMENTS.

Pests and Diseases.	Treatment.	Period.
Aphides and Capsid.	8% D.N.O.C.	January and February.
American Gooseberry Mildew. (Lime Sulphur should not be used on Sulphur sensitive sorts).	1½% Lime Sulphur *or* 20 lb. Washing Soda + 10 lb. Soft Soap + 100 gal. Water.	Early April and Late April.
Sawfly. (Application to depend upon incidence).	Derris or Lonchocarpus as dusts.	May–August.
Leaf Spot. (Application to depend upon incidence).	8 : 8 (12) : 100 Bordeaux Mixture *or* 15 lb. Bordeaux Paste + 100 gal. Water.	July–August. (Immediately after crop has been harvested)

4. RASPBERRIES.

Raspberry Beetle.

This is a serious pest and much damage is caused both by the adult beetles and by their maggots, especially is this so in the case of the maggots. The small, fawn coloured beetle feeds on the young shoots, flower buds and open flowers of the raspberry, loganberry and blackberry. Damage to the flowers and flower buds results in loss of crop-weight and in the production of small fruits of imperfect shape. Eggs are laid in the blossoms during June and July and the maggots feed on the developing fruits. The maggots first feed on the drupelets causing them to become hard and blackened, later they work their way to the receptacle (" plug ") and feed on the central parts. Damaged fruits may be much distorted and have a very unattractive appearance and greatly reduced crops may result from the ravages of this pest.

A good commercial control of this pest is secured by one application of Derris either as a wet spray, or as dust, towards the end of June. In the case of severe infestation, it may be advisable to make two applications, the first when only a few blossoms are open and the second 7–10 days later. Derris used as a wet spray should be mixed at 2 lb. per 100 gal. of water or Lonchocarpus at 1 lb. per 100 gal. water, together with a spreader. A 5 per cent. D.D.T. dust is very effective against Raspberry Beetle. Whereas it is best to use D.D.T. in cases of severe infestation, its regular use might be inadvisable, because Red Spiders often become serious pests when this is done (see p. 230).

Cane Spot.

This disease is detected by the appearance of circular purple spots on the young canes. Later, these spots elongate with the growth of the canes and may become up to one quarter of an inch long, whereas a narrow margin remains purple, the centre part turns whitish. Later still, with the maturing of the canes, the spots become sunken and the bark splits. Infection takes place from May to October.

In addition to the advisability of propagating from material having commercial freedom from Cane Spot, and the cutting out of severely infected canes, a good control can be obtained by spraying with Lime Sulphur at 7 per cent. concentration or with Bordeaux Mixture at 12 : 12 (15) : 100. The application should be made at a time when the buds are beginning elongation during Spring. For severe cases, a second spraying

with Lime Sulphur at 2½ gal. to 100 gal. water may be given or with Bordeaux Mixture at 6 : 6 (9) : 100 when the white is showing of the first-flower buds.

Raspberry Mosaic.

There are at least three types of Mosaic symptoms and all are of virus origin. The symptoms are best seen on the foliage during late Summer when infected cases are characterized by yellowish mottlings of the leaves. It is not unusual for the leaves to take on a curled or irregular appearance. The disease for many varieties results in a gradual deterioration both in cane size and in cropping.

Growers are well advised to plant Mosaic free canes and to eradicate all infected stools during Autumn for the first two or three years after establishing a plantation. Furthermore, it should be ascertained whether a variety is a "carrier" or a "susceptible." A "carrier" variety does not so readily deteriorate as a result of Mosaic as a "susceptible" variety; hence "carrier" varieties may be planted in near proximity to each other, whereas "susceptible" varieties should be planted on their own.

SUMMARY OF ROUTINE PEST- AND DISEASE-CONTROL TREATMENTS.

Pests and Diseases.	Treatment.	Period.
Raspberry Beetle.	Derris or Lonchocarpus Dust containing not less than 1·5% crystalline Rotenone; or 2 lb. Derris or 1 lb. Lonchocarpus Ground root to 100 gal. Water ; or D.D.T. Dust containing 5% D.D.T.	June; one or two applications to depend on incidence.
Cane Spot. (Applications to depend upon severity of incidence).	(i) 7% Lime Sulhur or 12 : 12 (15) : 100 Bordeaux Mixture. (ii) 2½% Lime Sulphur or 6 : 6 (9) : 100 Bordeaux.	(i) May when buds are elongating (ii) June.
Mosaic.	Purchase Mosaic Free Material. Eradicate infected Stools.	September to October

5. LOGANBERRIES.

Raspberry Beetle.
Cane Spot. } See Raspberries, p. 216.

6. BLACKBERRIES.

Raspberry Beetle.
Cane Spot. } See Raspberries, p. 216.

Blossom Weevil. See Strawberries, p. 218.

7. STRAWBERRIES.

Aphides or Greenfly.

Several different species of aphides feed upon strawberry plants, but only one of these is considered to be of serious economic importance. This one is referred to as STRAWBERRY APHIS.

The Strawberry Aphis, although not so prevalent during mid-Summer, may be found on plants during Spring, Autumn and Winter months. Although aphides normally cause little apparent direct injury to strawberry plants, except in isolated instances where severe curling of leaves occurs, they can be responsible for a rapid deterioration of plants, since they are carriers of the damaging " Yellow Edge " virus disease.

Control measures against the incidence of Strawberry Aphis should be taken on nursery stock in order to facilitate the production of virus-free strawberry runners. The most effective control measure at present is a gassing treatment with vaporized nicotine. This may not be practicable where runner production is only on a small scale, since a special machine is required for the purpose. Failing the vaporized nicotine treatment, one or two wet sprayings with nicotine, depending upon the incidence of the pest, should be applied during the growing season at the rate of 8 oz. per 100 gal. water plus 8 lb. of soft soap. The spray should drench the plants thoroughly, wetting the undersides of leaves and the young folded leaves. The customary period of control treatments is May and August.

Blossom Weevil (" Elephant Beetle ").
Rynchites.

The small black and greenish beetles of these pests can be responsible for considerable injury, because they may sever and cause the death of entire blossom trusses, as well as of individual blossom buds and young leaves.

Control, until recently, has been affected by dusting with a Derris or Lonchocarpus dust at the rate of about 50 lb. per acre.

Application is made when the pests are known to be doing damage; not infrequently two or three applications are required during the period immediately before and during blossoming. Recent work has demonstrated that a 5 per cent. D.D.T. dust most effectively controls these pests.

Strawberry Mildew.

This disease can be serious, especially under humid conditions. Whereas it may be first noted by dark blotches appearing upon the leaves, the fungus actually grows on their under surfaces, and is of a whitish grey appearance. As the infection develops by the rapid production of conidospores, the leaves take on an upward curl and are usually characterized by a purplish white appearance. In the early stages, it is not unusual for flowers and flower stalks to become infected, the former developing a ghostly white appearance and the petals may turn pink, and these tend to adhere to the receptacle rather than fall away after the blossoming period. In severe cases the fruits fail to develop normally, often remaining as small dried specimens. During the early part of a season individual fruits may be infected, either completely or only on one side, and when such is the case, infection usually increases with subsequent pickings as the season advances.

Control measures can be very effective if put into operation in time, which is usually during the blossoming period. Treatment takes the form of dusting with Flowers of Sulphur at about 50 lb. per acre.

Virus Diseases.

Yellow Edge and Crinkle.

These diseases may be responsible for a premature and severe deterioration of infected plants, especially to "susceptible" varieties. Some varieties while infected with the diseases themselves and thereby being "carriers" do not readily deteriorate. The diseases are transmitted notably by the Strawberry Aphis (see p. 218). "Yellow Edge," as the term implies, can be recognized by the yellowing of leaf margins and, whilst in the early stages only young leaves may show infection or only individual lobes of young leaves, it is usual for symptoms to develop rapidly throughout the entire plant. In addition to the marginal yellowing, much stunting of the leaves and, subsequently, of the plants normally occurs.

"Crinkle" whilst of less economic importance than Yellow Edge, and can be tolerated without apparent adverse effect in its mild form, causes plants to become worthless in its severe

phase. Commercially, "severe" Crinkle may be regarded as a distinct disease to "mild" Crinkle. The term Crinkle implies distortion or buckling of leaves caused by irregularities in growth; this is preceded by the appearance of tiny pale spots on the leaf surface, the centre of each spot becomes red and later turns brownish.

Control over these diseases can only be effected by the raising of disease-free plants and the elimination of all infected plants together with any runners they bear (see p. 264). The elimination of infected plants is best done during September, when symptoms are easiest to see. Little advantage can be obtained by the elimination of infected plants from plantings established for fruiting after the first year. It is essential to concentrate on healthy runner production and to plant at distances sufficiently wide to allow for the elimination with reasonable ease of parent plants together with runners. The control of the Strawberry Aphis is possibly the surest means of reducing infection. It is very important that "susceptible" varieties such as Royal Sovereign should not be grown in near proximity to other varieties. When purchasing runners for planting, growers should only purchase stocks which carry a Ministry of Agriculture certificate number indicating they have been inspected and approved for planting purposes.

SUMMARY OF ROUTINE PEST- AND DISEASE-CONTROL TREATMENTS.

Pests and Diseases.	Treatment.	Period.
Aphides.	Vaporized Nicotine or 8 oz. Nicotine to 100 gal. water plus 8 lb. Soft Soap.	Depending on Infection; usually May, also August.
Weevils.	Derris Dust or Lonchocarpus Dust or 5% D.D.T. Dust.	April and May.
Mildew.	Flower of Sulphur Dust.	May or June.
Yellow Edge and Crinkle.	Elimination in nursery and maiden plantings.	September to October.

TREE FRUITS.

1. APPLES.

Apple Scab.

There is no disease of such serious economic importance as apple scab. Although all varieties of apples are not equally

susceptible to " Scab " (in fact a few sorts are markedly resistant) yet it can be very devastating to some of the most widely grown sorts because it affects foliage, fruits and shoots. As the common name " Scab " implies, scab-like or blister-like wounds are formed on infected parts.

The scab-fungus may pass the Winter on infected leaves that fall from the trees during the Autumn and in young shoots and spurs on the tree. Ascospores are discharged from the old infected leaves into the atmosphere during Spring, this usually takes place during the latter part of April and coincides with warm, humid conditions. The disease can first be recognized by the appearance of sooty-coloured spots on the leaves, prior to an infection of the fruit. Further infection comes from the infected shoots and spurs on the trees, and each initial infection may become a centre for further infection.

The amount of damage done by Apple Scab differs greatly, in cases of mild infection, only a small proportion of the fruits borne may have unsightly blemishes. In severe cases, not only does a large proportion of fruits have unsightly blemishes and a much distorted appearance, but there is then, invariably, a great loss of crop due to premature dropping. Whereas a fruit may continue to grow normally on the side free of infection, distortion results, due to restricted growth at the infected points, and actual cracks often develop in the regions or severe scab wounds. Similarly foliage may be very blistered in appearance, greatly reduced in size and in severe cases, actually fall from the trees prematurely. On young shoots, much blistering of the bark may occur when infection has been severe on the leaves. Whereas a variety like Bramley's Seedling can have severe leaf infection and little infection on young shoots, varieties like Worcester Pearmain, Cox's Orange Pippin and Laxton's Superb will develop severe blistering, which often results in the death of the terminal portions of many shoots. This form of Scab injury increases susceptibility to the Apple Canker Disease (see p. 224). It should be noted that a high Nitrogen balance increases susceptibility to the Apple Scab disease.

From the foregoing, it is apparent that trees are vulnerable to the Scab fungus during the entire growing season and particularly so during moist warm weather. In view of this, the disease cannot be resolved by a single spray treatment, but invariably a number of sprays have to be applied from the period of bud break to that of full leaf development. Usually four sprays with Lime Sulphur suffice to give an adequate

control. Most of the recommended sorts are highly tolerant of Lime Sulphur applications, although late post-blossom applications should be avoided on the varieties Grenadier, Lord Derby and Newton Wonder (see p. 57). Fortunately these sorts are not so subject to the disease as many, and so late post-blossom sprays are seldom rendered necessary, except possibly with the late-maturing sorts like Newton Wonder; here Bordeaux Mixture, or Copper Lime Dust is usually resorted to in place of Lime Sulphur. Of recent years a spray preparation under the trade name of " Venturicide " has been employed on sulphur sensitive varieties (see p. 290).

Even four sprayings will not suffice to prevent considerable Scab infection on varieties like Worcester Pearmain and Bramley's Seedling when moist and warm conditions coincide with a long period (i.e. more than 10 days) between two sprayings at the time of ascospore discharge. Much depends upon the watchfulness of the grower, under such conditions, and in his timing of the sprays. Some growers favour Copper Lime Dust as an auxiliary to wet spraying, whereas others apply an additional wet spray as occasion demands.

Obviously good coverage of young wood and all growing parts (i.e. leaves, shoots, and flower buds or fruits), is required when spraying, to prevent or control this disease. It is necessary for a grower to be familiar with the stages at which spraying should be done, the materials to employ and the degree of dilution required for the respective sprays and different varieties.

First Spray Treatment.

Using 3 gal. Lime Sulphur to 100 gal. water at the " Green Bud " stage of blossom development (i.e. after bud burst, but while the blossom buds are green). This stage of development normally comes a few days before the period of main ascospore discharge which is usually during the second or third week of April.

Second Spray Treatment.

Using 2 gal. Lime Sulphur to 100 gal. of water at the " Pink Bud " stage (i.e. when the pink, white or red colour, according to the nature of a variety) of blossom petals is showing, but before blossoms have actually opened.

Third Spray Treatment.

Using 1 gal. Lime Sulphur per 100 gal. water at the " Petal Fall " stage (i.e. immediately after 80 per cent. of the blossoms

petals have fallen). This can be applied to all varieties listed (see pp. 57–58), with the possible exception of Newton Wonder; nevertheless in spite of a certain amount of spray injury, many growers give Newton Wonder a "petal fall" Lime Sulphur application. The alternative to Lime Sulphur for Newton Wonder is Bordeaux Mixture at 6 : 6 (9) : 100 or Bordeaux Paste at 10 lb. per 100 gal. water. Some growers prefer to apply a combined spray of Lime Sulphur and Colloidal Sulphur, or Lime Sulphur and a Dispersible Sulphur to varieties such as Cox's Orange Pippin, Miller's Seedling, Grenadier and Lord Derby, which may be regarded as border-line sensitive sorts. In such cases, ½ gal. Lime Sulphur plus 3–5 lb. Colloidal or Dispersible Sulphur to 100 gal. of water is applied as the "Petal Fall" spray treatment.

Fourth Spray Treatment.

Using ¾–1 gal. Lime Sulphur per 100 gal. water at the "Fruitlet" stage, i.e. about two to three weeks after the "Petal Fall" spray, when the young fruits are about the size of small walnuts. Omit this spray from the varieties Newton Wonder, Lord Derby, Grenadier and Edward VII (the last named variety being markedly resistant to Apple Scab). For Cox's Orange Pippin, Laxton's Fortune, Miller's Seedling and Ribston Pippin apply at the ¾ gal. strength per 100 gal. water. For these varieties some growers prefer to apply ½ gal. Lime Sulphur plus 3 lb. Colloidal or Dispersible Sulphur to 100 gal. of water.

It is necessary to spray young unproductive trees as well as older productive ones, although two or three sprayings normally suffice. These should take the form of a 3 per cent. Lime Sulphur spray about the middle of April and a 1 per cent. Lime Sulphur spray about the end of May. Copper Lime Dust is a particularly useful adjunct to wet spraying in localities that are very subject to Scab, especially for varieties such as Bramley's Seedling and Newton Wonder and it is applied at the rate of 40–70 lb. per acre.

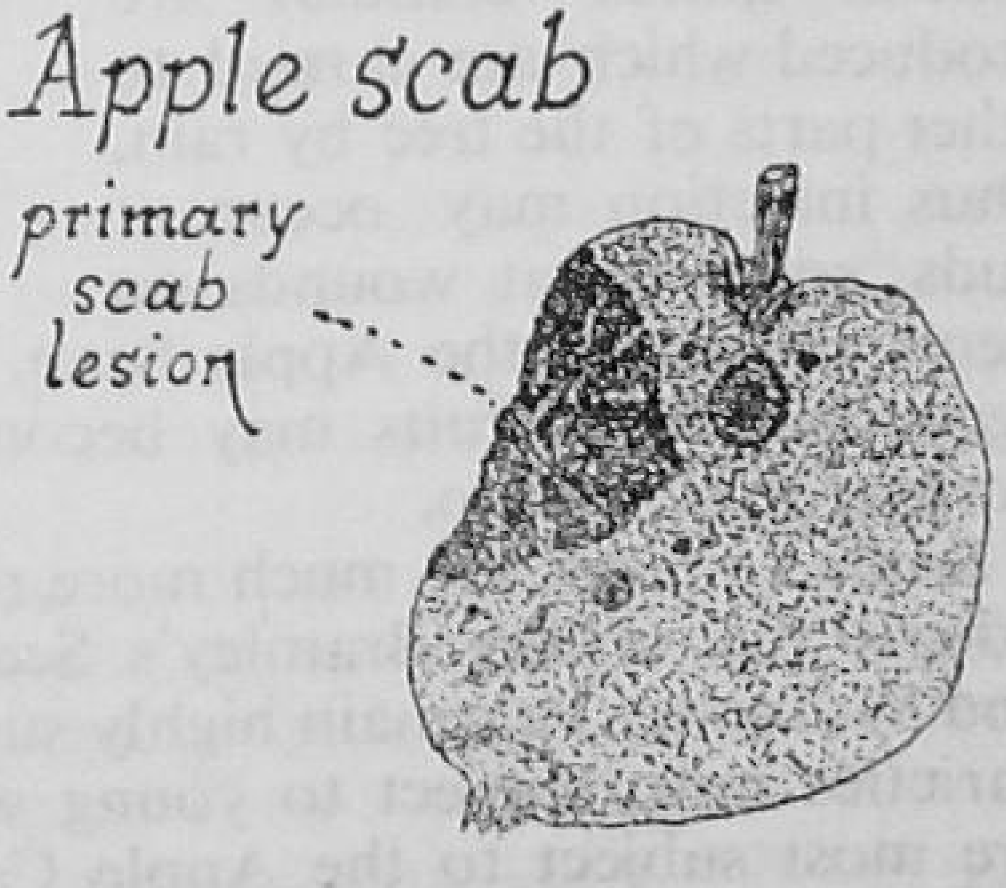

Fig. 20

The varieties Lord Derby, Miller's

Seedling, Worcester Pearmain and Cox's Orange Pippin should normally be regarded as copper sensitive and dusting with Copper Lime Dust should be avoided after blossoming.

Apple Canker.

This disease, whilst most noticeable on stems and branches, also affects spurs, shoots and fruits. Frequently it causes the death of stems and branches by girdling them. The girdled portion appears as a sunken, dead area, commonly referred to as a "Canker." Sometimes, especially on fairly stout branches, complete girdling is not effected and the branch continues to live, although it may make little growth in relation to normal branches. Usually the woody parts of a stem are infected, both above and below the actual region of the canker and brown discoloration of the wood can be seen on cutting into the stem.

From established cankers, ascospores are discharged from red-coloured fruiting bodies (perithecia) during the Winter. From newly formed cankers, whitish spores (conidia) are produced which are carried to other parts of the tree by rain. Thus infection may occur at buds, spurs or at wounds on stems caused by the Apple Scab fungus (see p. 220), or other agencies. Also fruits may become infected, causing the eye portion to go rotten.

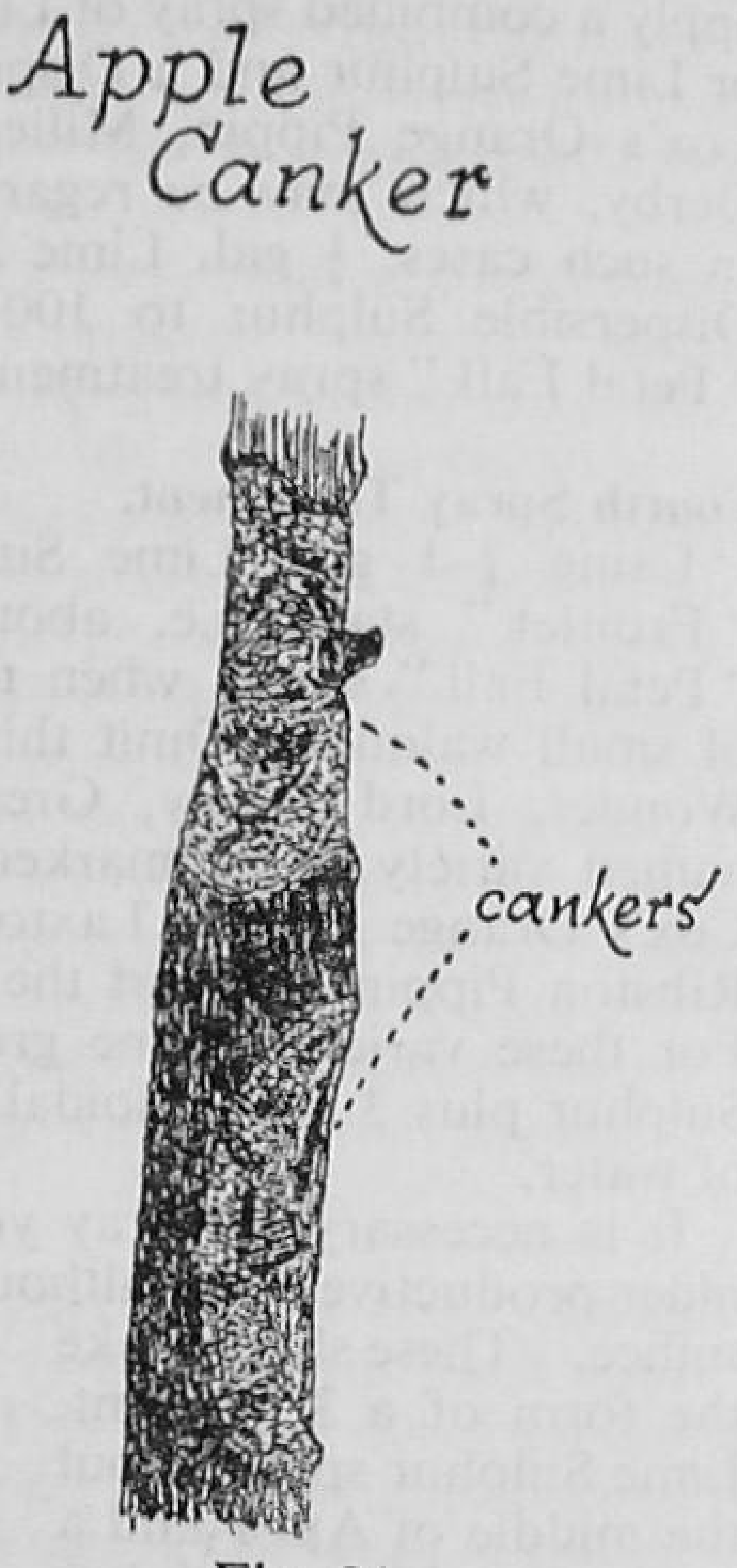

Fig. 21

Some varieties are much more resistant to Apple Canker than others, the variety Bramley's Seedling being notably resistant and Worcester Pearmain highly susceptible. Generally speaking, varieties most subject to young wood infection of Apple Scab are most subject to the Apple Canker Disease. Furthermore, there is an undoubted relation between the vigour of a variety, and its predisposition to Canker. In fact it can be asserted

that any pronounced incidence of Canker points to faulty cultural or nutritional conditions and that satisfactory control can only be affected by making suitable changes in the cultural and nutritional side. Just as some varieties are more subject than others, so strong growing unproductive trees are more subject than older ones yielding satisfactory crops. It should be pointed out therefore that the occasional canker on the young trees does not necessarily call for cultural changes, because there is normally an automatic reduction of incidence when useful crops are borne.

The following control treatments are, as a rule, effective, especially if soil drainage is reasonably suited for the varieties affected:—

(i) The maintenance of a complete spray programme against Apple Scab (see pp. 220–223).

(ii) The elimination by pruning of infected parts so far as is practicable. Where this is not practicable, the painting of large cankers with a stiff paint prepared by a mixture of Copper Lime Dust and Boiled Linseed Oil.

(iii) For young trees, and trees with only moderate infection, the reduction or omission of nitrogen from the manuring programme for two or three years.

(iv) For strong growing tress, 6 to 10 years old, and productive trees with more than moderate infection, apply to grass management (see pp. 116–118). It is generally wise, in such instances, to allow a temporary nitrogen shortage to occur.

Aphides or Greenfly.

Four species are of considerable importance to fruit growers. viz. *Green Apple Aphis*, *Oat Apple Aphis*, *Rosy Apple Aphis*, *Woolly Aphis*.

With the exception of Woolly Aphis, re-infection occurs from year to year from eggs laid in the Autumn either singly, on branches, shoots and spurs, as is the case with Rosy Apple Aphis, or in masses along the young shoots, as happens with the Green Apple Aphis.

Injury by these pests is caused to foliage, shoots, blossoms and fruits. Aphides, with the exception of Woolly Aphis, are mostly found on the undersides of leaves which they cause to curl. Similarly a curling or twisting of shoots results, and affected fruits fail to grow normally, remaining small and distorted.

The Woolly Aphis exudes a white, wool-like, waxy substance by which its presence can readily be detected. It is found

chiefly in crevices, on pruning wounds, especially in positions of shade, and in severe cases, it will be found on young shoots starting in the axils of leaves or other crevices and sometimes invading the entire length of the shoot.

Effective control of most aphides can be secured by spraying during Winter either with a tar Distillate or a D.N.O.C. spray; the former should be used at a 5 per cent. concentration, although a 10 per cent. concentration should be used against serious outbreaks of Woolly Aphis, and the latter at an 8 per cent. concentration (see pp. 288, 289). A Tar Distillate spray should be applied by the end of January and a D.N.O.C. by late February. It is essential, when spraying against Woolly Aphis, to cover all the crevices of old and young wood. The control of aphides during the post-dormant season is not easy to obtain unless treatment is very thorough and unless the remedy is applied during the early Spring before any leaf curling has occurred; a Nicotine spray at 8 oz. per 100 gal. water plus a spreader is used. During the Summer months, a reasonable control of Woolly Aphis can only be obtained when a spray capable of dissolving the waxy wool is employed, and for this a Summer Petroleum oil spray at 1 gal. per 100 gal. water is employed. A drenching spray is required, because only this will reach all crevices; this is not easily accomplished when foliage is present (see p. 201). A parasite (*Aphelinus mali Hald.*), which feeds on Woolly Aphis has been successfully employed by many to eradicate this pest.

Caterpillars.

There are several caterpillars of economic significance of which the following may be regarded as the most important: *Winter Moth*, *Mottled Umber*, *March Moth*.

The adult female moths are wingless and they usually gain access to trees by climbing up the trunks to the spurs and shoots where they lay their eggs. Great damage can be done by the caterpillars of these moths and in the absence of control measures, the young foliage may be devoured in its entirety. Even a moderate infestation can result in a big reduction of leaf surface and fruit blemishes may occur, due to parts having been eaten away during May and June.

Effective control of caterpillars may be obtained by spraying with Lead Arsenate or D.D.T. Lead Arsenate should be applied at the rate of 2 lb. per 100 gal. water at the Green and Pink Bud stages of blossoming (see p. 222). It is important that spraying should be done before blossoms are actually open,

in view of the damage that would be done, later on, to beneficial pollinating insects. Lead Arsenate may be incorporated with the pre-blossom Lime Sulphur sprays. D.D.T. should be applied by the Pink Bud stage of blossoming, as a spray, at a 0·1 per cent. concentration of actual D.D.T.; it can be applied with pre-blossom Lime Sulphur sprayings. Early sprayings of D.D.T. should be favoured, because later ones are likely to foster the development of the fruit tree Red Spider pest (see p. 230), and also because D.D.T. is normally required as a control against the Apple Blossom Weevil pest (see p. 229). The period recommended for application is about from mid-March to the end of the month.

The application of bands of grease, manufactured for the purpose, to the stems of trees can be a valuable means of checking the severity of infestation. It is most useful for tall trees, the tops of which are not easy to spray. For trees with a stem diameter of 4 inches and over, the grease may be applied direct to the stems as narrow bands. The principle of the grease band method of control is to trap the wingless female moths as they climb up the trees for the purpose of egg laying. It is therefore important to apply grease by the end of September and to freshen it periodically during Winter so that the surface retains a sticky character.

Winter spraying is only partially effective as a control measure, this applies both in respect of a 5 per cent. Tar Distillate and of an 8 per cent. D.N.O.C. spray. Where the Distillate is followed by an 8 per cent. Winter Petroleum spray about the middle of March, a good control of caterpillars should result.

Apple Sucker.

The damage caused by this pest is confined to the flower trusses where it feeds by sucking; it is thus capable of causing the death of individual flowers or entire trusses. The eggs are laid principally on blossom spurs during Autumn, and from these a wingless nymph form hatches during April and May. The nymphs feed on flower trusses at the base of the flower stalk. Their presence can be noted by sticky globules and a waxy substance which they excrete.

Apple Sucker can be controlled by spraying with a 5 per cent. Tar Distillate or an 8 per cent. D.N.O.C. spray. The Tar Distillate spray being the more effective if infestation is severe.

Apple Capsid Bug.

This pest feeds by sucking and damages fruits, shoots and

foliage. The most serious damage is done during Spring when the young fruitlets, shoots and leaves are developing. The "bug" hatches, before blossoming time, from eggs laid in the bark of young shoots during the early Summer. In the early stages it will be found chiefly in the shaded parts of unfolding blossoms and spur leaves. The Capsid Bug passes through six stages by repeatedly shedding its skin and becoming larger each time, until the fully grown winged adult stage is reached. The bug punctures young fruitlets, making one or many punctures in the same fruit. Each puncture, although tiny at the outset, results in considerable malformity as the affected fruits increase in size. Eventually the markings appear as a corky russet, they are of irregular shape and size and their surface is usually irregular. The leaf markings appear as clusters of dark brown spots, chiefly along the mid-rib; this becomes more apparent as damaged leaves increase in size. As would be expected, affected leaves fail to grow out normally and they are somewhat irregular or curled in appearance. Injury to the stems of young shoots is characterized by scars on the bark and some malformation, they may appear bent or twisted, a forked growth may occur and leaf buds may be closer together than usual.

Injury caused by apple capsid bug

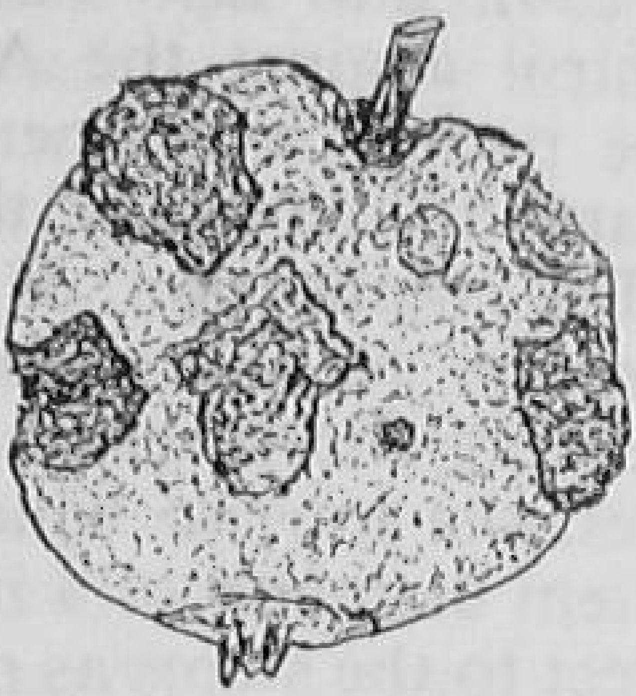

Fig. 22

The most effective control, until the advent of D.D.T., was obtained by spraying with a petroleum spray during February or March. This material can either be applied as a Winter Petroleum spray at 8 per cent. or as D.N.O.C. at 8 per cent. concentration. The D.N.O.C. spray should not be applied later than the early part of March. There is evidence to suggest that D.D.T. applied at a 0·1 per cent. concentration (see p. 229) at about the end of March, or approximately the "Green Bud" stage of blossom development most effectively controls this pest (see p. 222). Spraying with Nicotine at 8 oz. per 100 gal. water plus a spreader applied as a drenching spray, under still and warm conditions during the "Pink Bud" stage of blossom development (see p. 222), is a useful deterrent. Thorough spraying is essential to secure a control of this pest.

Apple Blossom Weevil.

Considerable crop reduction and foliage injury can result from this pest, especially on trees neighbouring woodland, and more extensively during years when blossom bud is scarce. The adult Weevil commences feeding on blossoms during the early Spring at about the " Bud Burst " stage, when the first green tips are visible. Characteristic punctures are made and these are clearly visible as the first spur leaves unfold. Only a day or so may be spent feeding before egg laying commences, and this proceeds during the " Bud Burst " and " Green Bud " stages. With their long snouts, weevils pierce through the protective leaves into the blossom buds where eggs are deposited. Blossom buds attacked in this way usually fail to open because the folded petals die and turn brown, as a result of the feeding of weevil grubs on the inside portions of the flowers. These unopened brown blossom buds are commonly referred to as "capped blossoms." Adult weevils, as they emerge from the "capped blossoms," spend some time feeding on foliage and fruitlets until about July, in some cases doing considerable injury.

The only satisfactory control is D.D.T., for preference applied as a wet spray at the " Bud Burst " to " Green Tip " stage. This may be applied either as a separate spray, or with Winter Petroleum or with Lime Sulphur. In practice, most growers prefer to apply D.D.T. in combination with another essential spray in order to avoid an additional spray application. When applied with Lime Sulphur, it is necessary to bring forward by a week or so the first Lime Sulphur spray (p. 222). Obviously care must be taken not to neglect Scab control and it may be necessary to make an additional application. Control measures against Apple Blossom Weevil are only necessary when blossom bud is not plentiful and for orchards planted near woodland, and so particularly subject to injury. D.D.T. may be applied at a 0·05 per cent. concentration although the more usual concentration is 0·1 per cent. in order to avoid a further application against caterpillar. Commercial products of D.D.T. contain different percentages of D.D.T., thus the actual quantity of D.D.T. preparations will be different in different cases. A 16 per cent. D.D.T. emulsion would be applied at the rate of about 5 pints per 100 gal. water to yield a 0·1 per cent. dilution. A wettable D.D.T. powder containing 20 per cent. D.D.T., should be applied at 5 lb. per 100 gal. water.

Apple Sawfly.

It is the caterpillar stage of this pest that damages young fruitlets causing them to fall to the ground. Eggs are laid by adult Sawflies in the flowers, they are deposited singly in a slit made by the ovipositor. The position of the slit occurs at the junction of the calyx with the receptacle and they can easily be seen by inverting affected blossoms. The eggs usually hatch within a fortnight of blossoming and the caterpillars that emerge feed on young fruitlets by boring into them, and soon a messy frass exudes from the entry point. Before a Sawfly caterpillar is fully grown it may feed on one or more fruitlets. Fruitlets attacked by the Sawfly caterpillar seldom grow out to a size larger than that of walnuts before they fall to the ground. It should be noted that the pest shows a distinct preference for certain varieties of which Worcester Pearmain is one.

This pest is controlled by spraying with nicotine at 8 oz. per 100 gal. water plus a spreader. In order to secure a good control, it is essential that the nicotine should come into contact with the eggs, this can only be attained by using a drenching spray. About one week may be allowed to elapse after the bulk of petals have fallen before applying the spray. In the event of the grower having to make an earlier start, it is wise to include a wettable Derris or Lonchocarpus with the nicotine at the rate of 2 lb. or 1 lb. respectively. It is fortunate that the Petal-fall Lime Sulphur spray against Scab can be incorporated with the Sawfly spray, thus avoiding a separate spray (see p. 222).

Fruit Tree Red Spider.

Considerable injury is done by this pest to foliage upon which it feeds. Although no direct damage is done to the fruit, it can be responsible for the fruit failing to grow out to normal size and appearance and also seriously impair blossom bud formation. The mite of the Fruit Tree Red Spider is a chlorophyll feeder and preys mostly on the undersides of leaves, usually starting on the oldest in the central portions of a tree and causing them to lose their green lustre and subsequently to take on a dull bronze-like appearance. Damage is usually most severe during hot seasons, especially on dry, dusty soils. Conditions resulting in a relatively high foliage temperature favour breeding, when a number of generations can develop within the space of a few weeks. The eggs, which are red in colour, are laid in masses during Autumn on shoots, spurs and branches. Immature mites emerge as early as May and these

pass through a number of moults before reaching maturity, when they are deep red in colour. Later in the season, all stages may be found on the undersides of affected leaves at one and the same time, eggs, immature and mature mites. When such a condition is reached, control is exceedingly difficult to obtain.

The most satisfactory controls are provided by petroleum sprays applied either as a straight Winter Petroleum, during March, or as D.N.O.C., during January and up to the end of February at a 5 per cent. concentration. The variety Beauty of Bath should not be sprayed with D.N.O.C. later than January and with Winter Petroleum later than February. Thorough spraying is essential. The most effective Summer spray is Summer petroleum applied at a 1 per cent. concentration during mid–end of June. Summer Petroleum should not be applied during hot sunny conditions nor under conditions of pronounced mineral deficiency. Lime Sulphur employed in the Scab sprays is a deterrent against the mites themselves but affords no control against the eggs. In the event of mites being present after blossoming, a wettable Derris should be included in the second post-blossom Lime Sulphur spray.

Codlin Moth.

Few have not experienced disappointment upon biting an apple, only to find it has been tunnelled into by a maggot. The maggot responsible for this is almost certain to be that of the Codlin Moth. This pest is especially serious during hot dry seasons in old orchards, and affected fruits are caused to ripen and to drop prematurely. The moth which is on wing from early June onwards lays its eggs, which appear as white glistening specks, on the fruits and leaves. The grub chews its way into the fruits which it leaves when fully fed to find hibernation quarters in such places as under rough bark or in orchard buildings. On occasions there is more than one brood during a single season and a second spray is at times necessary.

Spraying should be done with Lead Arsenate powder at 2 lb. per 100 gal. water when it is evident that the pest is of economic significance. The spraying should coincide with egg laying, but the period is usually between the end of June and early July. Mercurated Lead Arsenate at a similar rate to that for Arsenate of Lead may be used by growers desirous of applying a combined insecticide and fungicide against late Apple Scab (see p. 222).

SUMMARY OF ROUTINE PEST- AND DISEASE-CONTROL TREATMENTS.

Pests and Diseases.	Treatment.	Period.
1. Scab.	3% Lime Sulphur.	Green Bud Stage (a little earlier when incorporated with D.D.T.).
2. Scab.	2% Lime Sulphur.	Pink Bud Stage.
3. Scab.	1% Lime Sulphur. For sulphur sensitive sorts use a 6: 6 (9):100 Bordeaux Mixture or 2 lb. Mercuriated Lead per 100 gal. water if caterpillar is present.	Petal Fall Stage.
4. Scab. (Omit for Newton Wonder, Lord Derby, Grenadier and Edward VII.)	¾–1% Lime Sulphur or ½% Lime Sulphur plus 3 lb. Colloidal or Dispersible Sulphur or 2 lb. Mercurated Lead (if caterpillar is serious).	Fruitlet Stage.
5. Capsid Bug, Apple Blossom Weevil, and Caterpillars.	0·1% D.D.T.	Bud Burst to Green Tip Stage with Nos. 1 or 8.
6. Sawfly.	8 oz. Nicotine to 100 gal. water plus Spreader.	Petal Fall Stage with No. 3.
7. Aphis and Sucker.	5% Tar Distillate wash.	November to end of January. Omit if No. 9 is used.
8. Capsid and Red Spider.	8% Petroleum (Winter). 5% when No. 5 is applied or when application is late.	March. Omit if No. 9 is used.
9. Aphis, Sucker, Capsid and Red Spider.	8% D.N.O.C. 5% when No. 5 is applied or when application is late.	January to early March. Omit if Nos. 7 and 8 are used.

10. Caterpillars.	2 lb. Lead Arsenate Powder.	Green Bud and Pink Bud Stages with Nos. 1 and 2.
11. Codlin Moth.	2 lb. Lead Arsenate Powder or 2 lb. Mercurated Lead.	End of June and early July.
12. Red Spider.	(*a*) 1% Petroleum (Summer). (*b*) 2 lb. Derris (wettable), or 1 lb. Lonchocarpus.	June. Include (*b*) with No. 4.
13. Canker.	Efficient Scab control.	See Nos. 1, 2, 3, 4.
14. Canker.	Pruning and Painting.	Winter.
15. Canker.	Omission or reduction of Nitrogen.	For one or more seasons as necessary.
16. Canker.	Application to grass.	Spring or Autumn.

2. PEARS.

Pear Scab.

In view of the general similarity between Pear Scab and Apple Scab, for all practical purposes they can be regarded as one and the same disease. Of the varieties recommended (p. 58) Williams' Bon Chrétien, Clapp's Favourite and Fertility are the most subject to Scab; Doyenne du Comice, Laxton's Superb, Dr. Jules Guyot and Beurre Bedford are moderately susceptible; but the varieties Conference, Triomphe de Vienne and Bristol Cross are markedly resistant. One feature of interest is that whereas Apple Scab first becomes established on foliage, in the case of pears, it is usually the fruits that are first affected; this may be due to the difficulty of wetting pear fruitlets.

The control measures should be similar to those for Apple Scab. Normally two sprays of Lime Sulphur should suffice for the varieties Conference and Bristol Cross, one before blossoming at 2 per cent. and one at petal-fall at 1 per cent. It is claimed that improved wetting of fruitlets can be obtained with Colloidal Sulphur and Wettable Sulphur, and on account of this some growers apply one or other of these forms together with Lime Sulphur in post-blossom applications (see pp. 223, 290).

Pear Canker. (See Apples, pp. 224–225).

It is most prevalent on Scab-subject varieties, especially when only a poor control of this disease is maintained, and where pear rootstocks are employed or scion rooting has occurred (see pp. 78, 88). Efficient Scab control, removal by pruning and reduction in Nitrogen manuring are recommended as control measures; grassing down is not advised for pears.

Caterpillars.

Winter Moth, Mottled Umber, March Moth. (See Apples, pp. 226–227). Attacks are seldom as severe as with apples, except near woodland sites.

Codlin Moth. (See Apples, p. 231).

Although Aphides (see pp. 225–226) and Red Spider (see pp. 230–231) may gain significance as pests on pears they are seldom as severe as on apples, nevertheless there are indications that Red Spider is on the increase. In view of this and the fact that the Green Capsid Bug (see pp. 227–228) is rarely severe, Petroleum Winter sprays are not so generally used as with apples. It is customary to use a 5 per cent. Tar Distillate wash during Winter although this is not essential every year.

For: **Summary of Routine Pest- and Disease- Control Measures.** (See Apples, p. 232, Nos. 1, 2, 3, 4, 7, 9, 10, 11, 13, 14 and 15).

3. PLUMS AND DAMSONS.

Silver Leaf.

This is the most serious disease of plums and of the varieties recommended (p. 58), Victoria, Czar and Early Laxton are the most susceptible. Silver Leaf is a fungous disease that enters at a wound and invades the wood, thereby causing affected branches and trees to die. Death of an entire large sized tree from Silver Leaf is normally a slow process, taking two or more years. After infection and before death, the foliage of infected branches takes on a characteristic silvered appearance (i.e. a milky whitish colour masks the green). Spores of the Silver Leaf fungus are only produced on dead wood. The fruiting bodies of the fungus appear on the surface of infected dead wood as flattish projections with raised irregular edges, of a purplish colour on the lower surfaces and yellowish brown on the upper surfaces. Spores are yielded by spore producing cells (basidia) formed on the lower surfaces.

No actual curative measures are known once trees have contracted the disease, although much can be done by cultural

means to reduce its commercial significance. Also it should not be assumed that once a tree exhibits silvered leaves that it is always doomed to die. In the event of the infection being recognized in its early stages, the affected part can be removed. Care should be taken to sever an infected branch below the point of infection, which means that the wood at the point of removal should be free of purplish-brown staining. Each Autumn all sources that would give rise to further infection should be removed and burnt, this includes all dead trees and branches that have died as a result of Silver Leaf as well as neighbouring sources of infection that may be present in woodland or wind breaks. It is also a wise precaution to eliminate all trees with foliage severely silvered where death due to the disease is imminent. Since it is usual for the disease to enter at wounds, subject varieties should be pruned as late as possible, preferably not until May or June, since infection is most likely to occur during Autumn and Winter and does not take place during June, July and August. Large wounds that are slow to form callus, or an effective gum barrier, should be painted over with a fungicidal paint such as Bordeaux paint (see p. 225). Even moderate sized wounds made on subject varieties from October to May should be painted over.

Silver Leaf often becomes very prevalent after heavy crops when considerable branch breakage has occurred. Much can be done to prevent breakage by suitable pruning especially in the early years (see pp. 173–182). Shoots arising from narrow forks should be rejected for branch forming purposes. Long leaders should not be left unpruned since they invariably break at the point of bend during subsequent years, when a heavy branch system has formed at their extreme end; furthermore, big lateral branches should not be allowed to form when they exert a pull in the opposite direction from the parent branch. The crops from subject varieties should not be harvested by ladders but rather by " three-legged stools " that do not have to be supported by the branches. Immediately upon harvesting, all broken branches should be dealt with, by removing them below the break and painting over the wounds.

Brown Rots.

These diseases are responsible for causing fruits to go rotten. One (*Sclerotinia laxa*) also infects blossoms and shoots causing them to wilt and infection often results in the death of blossoms, spurs and tips of shoots; it may even extend to branches causing a canker to girdle them. The other (*Sclerotinia fructigena*),

invariably causes the death of spurs that bear infected fruit. One of the chief sources of reproduction is from diseased fruits, which after rotting have shrivelled and remained on the trees as " mummied " fruits. Infected twigs, spurs and cankers are also sources of re-infection. Conidia spores are shed during Spring and Summer and infection is usually incurred by actual contact with infected fruits, or through fruits that have sustained some injury resulting in a broken skin.

Spraying against these diseases is seldom necessary, because they can normally be held in check by removing all " mummied " fruits and infected spurs. Spraying with Tar Distillate wash during Winter, especially when applied as late as practicable, say late January, at a 10 per cent. concentration is a useful control measure. In the event of the blossom-wilt form becoming serious, a 6 : 6 (9) : 100 Bordeaux Mixture or 2 per cent. Lime Sulphur spray should be applied at the " White Bud " stage of blossom development, i.e. just before full blossom.

Bacterial Canker.

For a description of this disease (see pp. 234–240).

Certain varieties of plums are very susceptible to Bacterial Canker, notably Czar, Early Laxton, Giant Prune and Victoria whereas most other sorts are comparatively resistant and some markedly so. The disease mostly affects young trees from one to eight years old. The canker injuries, in the case of plums, occur chiefly on the main stems which often become girdled, resulting in the death of trees affected in this manner. Even when a tree is girdled by a stem canker, it usually breaks into leaf during Spring, but the leaves do not attain full size and as the warmer weather comes, they turn yellow and, finally, wilt and die. The cankers are recognised by characteristic, flattened, dead areas.

Care should be taken in the propagation of susceptible varieties; firstly, only material from disease-free trees should be employed for propagation, and secondly, main stem infections can be eliminated by employing only stems of resistant varieties and head-grafting the susceptible varieties onto them. It is preferable to form a head from four or five young branches of the resistant sorts used as " stem builders," and to graft on to these branches rather than apply a single graft at the head of each tree (see pp. 91, 269).

Although spray treatments have given no appreciable reduction of stem cankers, Bordeaux Mixture at 4 : 4 (6) : 100, applied three weeks after Petal Fall, or about the third week of May,

gives an appreciable control of the "shot-hole" phase of the disease.

Aphides or Greenfly.

Leaf Curling Aphis. Mealy Plum Aphis. Hop-Damson Aphis.

In the case of both the Leaf Curling Aphis and Hop-Damson Aphis, small green aphides hatch out during early Spring from eggs laid on spurs and shoots. These aphides feed on the underside of developing leaves, causing them to become very distorted and curled and not infrequently to die. Winged forms develop later in the season and migrate to other hostplants.

The Mealy Plum Aphis, whilst not causing leaves to curl up in the same manner, is characterised by a mealy appearance, causing the foliage to take on a greyish sooty appearance.

Control measures for plum aphides are the same as for Apple Aphides, viz. Tar Distillate Wash at 5 per cent., or D.N.O.C. at 6 per cent.

Caterpillars.

Winter Moth, Mottled Umber, March Moth, Early Moth. (See Apples, pp. 226–227).

Control measures are the same as recommended for apples, viz. Lead Arsenate at 2 lb. per 100 gal. water, normally the best time of application is about the Petal Fall stage of blossoming.

Fruit Tree Red Spider. See Apples, p. 230.

Plum Sawfly.

This pest can be serious in certain orchards, and particularly on certain varieties. Varieties readily attacked include Early Laxton, Czar and Wyedale (this last named variety does not appear in the list of recommended sorts (p. 58), it is a plum of poor quality, but is grown by many on account of the lateness with which it can be harvested).

The damage is done by the caterpillar, which hatches out from an egg laid in a slit, made by the parent, in the receptacle of an open flower. The caterpillar emerges about a fortnight after blossoming, at a time when the flower receptacle breaks away from the expanding fruitlet. Until this stage, the receptacles serve as a sheath round the tiny fruitlets. Upon emergence, the caterpillar bores into the fruitlets and feeds on the developing kernel, and moves thence to other fruitlets until fully fed. Affected fruits can be recognised by the neat black holes bored into them; they fail to mature and fall to the ground.

This pest can be readily controlled, provided that the timing of an appropriate spray is correct. The spray usually employed consists of 8 oz. Nicotine, 2 lb. Derris (or 1 lb. Lonchocarpus), plus spreader to 100 gall. water. Both Nicotine and Derris used separately with Spreader can be effective, although the combined wash is more dependable. The mixture should be applied as a drenching spray at the time when the receptacle, which forms a sheath-like band round the fruitlets and is referred to by many as the " cot," is commencing to split as a result of the swelling of fruitlets. Alternative to the Nicotine Derris spray a combined Derris and Petroleum Oil spray is frequently used at a 1 per cent. concentration.

Red Plum Maggot.

This pest can be regarded as the equivalent of the Apple Codlin Moth (p. 231). The moths which are on wing from early June, deposit eggs on fruits and leaves, and these appear as glistening specks. The damage is done by the caterpillar which on hatching out bores into a fruit and feeds on the region surrounding the stone.

This pest can be controlled by spraying with Lead Arsenate at 2 lb. per 100 gal. water at about the end of June. It should be mentioned that in the case of early varieties, a spray deposit is likely to be visible at the time of harvesting and for such, Derris at 2 lb. or Lonchocarpus at 1 lb. per 100 gal. water is used in place of an arsenical spray.

SUMMARY OF ROUTINE PEST- AND DISEASE-CONTROL TREATMENTS.

Pests and Diseases.	Treatment.	Period.
1. Aphides. Brown Rot.	5% or 10% Tar Distillate.	November–January Omit when No. 2 is used.
2. Aphides. Red Spider.	6% D.N.O.C.	January–early February in place of (1).
3. Sawfly and Red Spider, (apply when significant as a pest).	2 lb. Derris plus 8 oz. Nicotine plus Spreader plus 100 gal. water or 1 gal. Derris in Petroleum oil.	" Cot " splitting stage about 8 days after Petal Fall.

4. Brown Rot (apply when significant as a disease).	6 : 6 (9) : 100 Bordeaux Mixture, or 2% Lime Sulphur.	" White Bud " stage of blossoming.
5. Bacterial Canker, (apply when significant as a disease).	4 : 4 (6) : 100 Bordeaux Mixture.	3 weeks after Petal Fall.
6. Red Plum Maggot, (apply when significant as a pest).	2 lb. Lead Arsenate or 2 lb. Derris plus 100 gal. water.	End of June.
7. Caterpillars.	2 lb. Lead Arsenate.	Petal Fall stage. Combine with No.3.
8. Silver Leaf.	Pruning and painting.	May and June.
9. Bacterial Canker.	Employment of Stem Builders.	In Nursery or after Planting.

4. CHERRY.

Brown Rots. See Plums, p. 235.

Growers who normally apply Bordeaux Mixture for the control of Bacterial Canker are not much troubled with Brown Rot diseases, except during seasons when cherry skins are predisposed to crack. Furthermore, they are not so prevalent in trees that are pruned to facilitate good aeration.

Bacterial Canker. See Plums, p. 236.

In the case of cherries, this is responsible for a high percentage of casualties especially with certain varieties, and most especially with young trees. Of the recommended sorts (p. 59), those most affected by Bacterial Canker are Napoleon, Emperor Francis, Bradbourne Black, Florence and Amber.

As the name of the disease implies, cankers result from infection, and these may occur on spurs, shoots and branches. In the event of an affected part becoming girdled by a canker, death of the portion above ensues. A frequent position of infection is the crotch at the region of graft union, and this often leads to the death of the scion variety. It has been demonstrated that the disease enters the stem during the Autumn and Winter months, principally about the time of leaf fall. The cankers

are characterized by a dead sunken area and it is usually found that gum, a carbohydrate formed by stone fruits, exudes from places surrounding them. An affected branch or tree invariably comes into leaf in the Spring even when completely girdled by a canker, but as the season progresses and drier conditions supervene, the leaves remain small, turn pale and subsequently wilt.

During the Summer the canker organism invades leaves. Affected leaves develop a "shot-hole" appearance. In the early stages of infection, tiny (pinpoint) yellow, almost transparent spots appear, and as these grow the central portion turns brown and drops out leaving a tiny hole. Sometimes a number of spots coalesce causing a larger hole. It would seem that from the leaves; buds, spurs and shoots become infected, leading to branch infection and thence to main branch infection. Without appropriate treatment a residuum of infection can be built up, to become progressively worse.

Spraying with Bordeaux Mixture is an effective control treatment, but should be regarded as cumulative in value rather than capable of securing immediate control. It usually takes two or three years' treatment before the maximum benefits are obtained. Two sprayings a year should be applied, one at a 10 : 10 (15) : 100 concentration at the time of leaf fall, say from late October to early November; and the other at a 6 : 6 (9) : 100 concentration at the "white bud" stage of blossom development, that is directly before blossoms have opened. The Autumn and Spring sprayings should be thorough, the former especially so, since it is intended that leaf scars, spurs, shoots, branches and crotches should be provided with a bactericidal covering. The Spring spraying is also helpful in controlling the Brown Rot Diseases (see p. 235) and Cherry Leaf Scorch Disease. Bordeaux Paste may be used as an alternative to Bordeaux Mixture at strengths of 10 lb. per 100 gal. water for the Spring application and 20 lb. for the Autumn application.

Caterpillars.

Winter Moth. Mottled Umber. See Apples and Plums, pp. 226, 237.

As with plums, Arsenate of Lead is effective when applied at the "Petal Fall" stage; also a 0·1 per cent. D.D.T. spray is effective and many now favour the D.D.T. spray.

Grease banding against these pests is specially beneficial for tall cherries, because difficulty is experienced in spraying the tops of the trees.

Aphides.

Cherry Blackfly.

This pest is most common on young trees. The black aphides infest young shoots, causing the leaves to curl. The tiny black eggs, which hatch out in the early Spring, are laid during September and October, chiefly on young shoots in the region of the buds.

In common with combating other aphides, an effective control can be obtained by the application of a Tar Distillate wash at a 5 per cent. concentration during the period of November to early February. When Brown Rot is prevalent a 10 per cent. application is advised (see p. 235).

SUMMARY OF ROUTINE PEST- AND DISEASE-CONTROL MEASURES.

Pests and Diseases.	Treatment.	Period.
1. Aphides and Brown Rot. Caterpillars (partial).	5% Tar Distillate, or periodically 10% Tar Distillate.	November to early February.
2. Bacterial Canker and Brown Rot.	6 : 6 (9) : 100 Bordeaux Mixture or 10 lb. Bordeaux Paste.	White Bud stage.
3. Bacterial Canker.	10 : 10 (15) : 100 Bordeaux Mixture or 20 lb. Bordeaux Paste.	Leaf Fall, approx. late October to early November.
4. Caterpillars.	2 lb. Lead Arsenate. or 0.1% D.D.T.	Petal Fall.
5. Caterpillars.	Grease Banding.	October.

APPENDIX I

ORCHARD RENOVATION

Thus far our space in this book has been devoted to the development of a good fruit farming enterprise. The start was made with open land and the story has proceeded to the requirements of fully established orchard and plantation fruit. Throughout, the story has been based upon exacting modern needs and a high standard of efficiency in management. It so happens that a grower is not always responsible for the planning and development of his own farm. Growers who come into possession of well-planned and well-managed fruit farms will doubtless discover for themselves the contribution that the foregoing pages can make in respect of subsequent management. Some growers may be less fortunate and come into possession of fruit that is not well-planned, or that has not been well-managed and therefore needs renovating if it is to be of economic worth.

Orchard renovation presupposes a state of neglect. It is not easy to define exactly what is meant by the term neglected orchard, because there is no hard and fast transition from the well-managed state to the neglected state. Renovation or restoration should only be contemplated for fruit with economic possibilities that has, for one or more reasons, failed to reach a high level of productive value. Orchards or plantations which have, by virtue of one or many reasons doubtful economic possibilities should be dispensed with.

There are three main considerations that serve to give guidance as to the relative merits of renovation and grubbing (i.e. complete clearance in readiness for other crops). The three considerations are (i) The present condition, (ii) Varieties, (iii) Age.

SOFT FRUITS.

These seldom merit renovation once they have got into a neglected state. They are short term crops of from three to twelve years, and the period of productive life after attempts at renovation is seldom more than a few years. Soft fruits get into a neglected state chiefly through lack of cultivation, nutritional deficiencies and the incidence and spread of pests and diseases.

Soil cleaning operations, to eradicate perennial weeds such as couch grass, are well nigh impossible in the presence of a growing crop of soft fruit. The correction of nutritional deficiencies such as potash and magnesium, when severe, takes from two to four years. It is to be doubted whether attempts to renovate strawberries with pronounced mineral deficiencies are ever merited, even when a high standard of clean cultivation is maintained. The same may be said of other soft fruits when the state of cultivation is poor. Provided a mineral deficiency is not severe, in the case of soft fruit crops only a few years old, except strawberries, and grown under otherwise satisfactory conditions, renovation is practicable. This applies especially when nitrogen and calcium are the deficient elements.

Before deciding on renovation the incidence of disease should be checked, since strawberries, blackcurrants and raspberries are markedly susceptible to various virus diseases (see pp. 212–219). No control measures are practicable against these diseases other than rogueing (i.e. the elimination of affected plants) and since virus diseases are always somewhat ahead of what is apparent when rogueing, it is doubtful whether any worthwhile improvement is likely when strawberry plants are more than 5 per cent. infected and when raspberries and black-currants are more than 10 per cent. infected.

When a poor state of growth is due to age or to adverse soil conditions, no attempt should be made to renovate, since grubbing is the only satisfactory expedient.

TREE FRUITS.

These lend themselves to much greater possibilities of satisfactory improvement than soft fruits, but even so, cases are not lacking where grubbing would have been the more satisfactory alternative.

In the first place, it is wise to take note of how many blank spaces already exist. Trees more than 15–20 years old in a poor state of development and with more than 20 per cent. gaps is seldom a worthwhile proposition even after renovation. The "gapping up" (i.e. the planting of trees in the blank spaces) of orchards which so far as their age is concerned are in their most productive phase cannot be recommended. Young trees planted in established orchards are usually slow to make headway and by the time they do become established the old established plant is rapidly declining (see p. 260).

There are three other orchard conditions frequently met with that do not merit attempted improvement or retention. The

first concerns those grown under totally unsuitable soil conditions, so that excessive stunting and, often, considerable disease have resulted. Such a case is clear evidence that the orchard should never have been planted, and the odds weigh heavily against ever making a success of it. The second type concerns old orchards of mixed sorts of doubtful commercial value. Admittedly even old apple and pear orchards, in otherwise reasonable conditions, may at times be satisfactorily head-grafted or framework-grafted to more profitable sorts, and the period of their useful life be thus extended (see p. 261). Against this it should be borne in mind that the chief cost associated with the grubbing of trees goes to the cutting down and clearing of branches (a cost that must be borne whether head-grafting or new planting is done) and that young trees can be brought into effective cropping within 4–10 years.

The third type of orchard referred to above that does not merit retention is the one where trees have been planted very much too close and have been in that state for several years. The probability is that the widening or " thinning " of such a plant would leave trees with a number of tall, poorly furnished branches. Sometimes a scheme of thinning is worth while, when coupled with dehorning of the permanent trees (i.e. those left after the others have been grubbed).

The entire grubbing of an orchard is seldom necessary as a result of neglect in such matters as cultivation, manuring, spraying and pruning, except perhaps for very stunted trees, accompanied by considerable death of branches.

Causes of the Neglected State.

An orchard may be failing to produce its most economic crops for one or several causes, viz. :—

(1) Pests and Diseases.
(2) Cultivations (faulty or neglected).
(3) Manuring (faulty or neglected).
(4) Pruning (faulty or neglected).
(5) Overcrowding.
(6) Protection (inadequate or absent).
(7) Pollination (inadequate or absent).
(8) Drainage (faulty).
(9) Gaps, Age and Varieties.

Sometimes a neglected state is due to a single cause, whereas in other respects conditions are satisfactory. A mineral deficiency, excessive pruning, no pruning, failure to control a specific pest or disease, or some other cause may rob a grower

of a satisfactory result. More often, however, the neglected state is attributable to a combination of several causes. Thus it may be necessary to eliminate a proportion of the trees, bring the orchard to a state of clean cultivation, prune, spray and apply fertilizers during the same dormant season, since Autumn and Winter are normally the best time to start orchard renovation. All treatments have a unique and necessary role to play in the successful renovation of an orchard, because the normal management of a highly productive orchard depends upon the combined effects of several distinct operations.

(1) Pests and Diseases.

Productive cropping can only be assured if preventative and control measures are directed against specific pests and diseases of economic significance. The state of orchard hygiene necessary to secure and safeguard effective cropping can only be obtained by the application of a suitable spray schedule in a satisfactory manner.

The question arises as to whether the same spray schedule is necessary for the orchard that has not been sprayed for several years as it is for the one that has been sprayed regularly. If an orchard merits renovation, then the same spray schedule against similar pests and diseases should be adopted. In order to achieve the same degree of thoroughness for the neglected orchard as for the well tended orchard, it should be noted that considerably more spray material is required for the neglected one. This is due to the presence, on neglected trees, of moss and lichen, which readily absorb the spray.

Not only is great loss of crop sustained in the absence of pest- and disease-control measures, the same applies if the measures are inadequate or faulty. Inadequate spray cover, due to poor equipment and lack of thoroughness of application, are the chief spraying faults met with; added to this is faulty timing. Loss of crop is seldom due to the employment of wrong materials.

Growers with neglected orchards, and those who have been deriving poor value from spray operations, are referred to the sections dealing with Spraying Systems and Appliances and The Principal Pests and Diseases and Their Control Treatments (see pp. 200, 210).

(2) Cultivation.

Neglect in the matter of cultivation results in an overgrowth of uncontrolled weed. When weed growth is excessive, and if

allowed to persist for a number of years, trees become debilitated. There comes a stage when the new season's growth is negligible, spurs and branches die, and the leaves, such as are formed, are small and pale. The trees may blossom profusely, but the flowers come from buds that are weak and undernourished and of a type that cannot mature to a satisfactory crop.

The general procedure for dealing with orchards of this description is to bring them to a state of clean cultivation, and this is best done by frequent disc cultivation, both down the rows and across the rows. An all over state of clean cultivation is needed, and therefore it is advisable to cultivate as close up to the trunk of each tree as is practicable. Following tractor-drawn disc cultivation, a small square is unavoidably left uncultivated round each tree, and this space is larger where bush and spreading types of trees are concerned than with the taller-stemmed, erect types. These squares must be dealt with by hand by "brishing" or "brushing" (i.e. cutting away undergrowth with bagging hooks) and digging. Numerous suckers may have formed from rootstocks or there may be thorns and brambles which have to be eradicated by mattock.

The first cultivation for very neglected orchards will of necessity have to be done before a Winter spray treatment. Where conditions are reasonably traversible, so much the better, since the cultivations may be deferred until after Winter spraying, but they should be well on the way by March if rapid drying out of the soil is to be prevented, as such a drying would tend to nullify remedial measures. The soil should be maintained in a clean state of cultivation until well into July (see p. 116) and in order to ensure this, frequent discings are necessary in the early Spring, when weed growth is active, and less frequent ones during the drier months.

Prior to the cultivations, it may have been necessary to grub a proportion of the trees (see p. 250). Also to facilitate cultivations, it is often necessary to remove low lying branches (see p. 248). Furthermore, it is often necessary to apply fertilizers before the first cultivations, particularly when these are carried out as late as March.

Poor tree conditions, or unsatisfactory cropping, is often the result of faulty cultivations rather than of neglect, and is based on a wrong assessment of tillage needs for a particular variety or for trees exhibiting a particular state of growth. For instance, excessive vigour may indicate that cultivations are excessive; and this, in the case of a variety like Worcester

Pearmain apple, points to the desirability of applying the orchard to grass management. Deep cultivations practised over a number of years are detrimental; especially is this so for cherries, a crop which is usually at its best under well managed grass orcharding. Poor growth results from allowing grass to become tall during Spring or early Summer, and the conditions may be further aggravated and prolonged when hay crops are taken. A restoration to normal vigour of trees with very poor growth generally necessitates a return to clean cultivation, or failing this, a generous manurial treatment (see p. 119 and "Manuring" in the section following this), accompanied by the maintenance of a short herbage during the Spring and early Summer months.

Sometimes, a fault of overthoroughness with cultivations is apparent. Although under conditions of clean cultivation, a high standard of tillage should be the aim from March until July when the conservation of soil moisture is the factor of primary importance, it is not profitable to continue with the cultivations during the Autumn months. Not only does the completely clean state lead to a rapid depletion of soil organic matter (see p. 113), it also increases the cost of management unnecessarily.

(3) Manuring.

For orchards where the cultivation or grass management has been completely neglected for several years, nitrogen is more often than not the chief nutritional requirement at the outset. A return to clean cultivation may not suffice to adjust a nitrogen deficiency when there is much hay-like material to decompose. Applications of about 5 cwt. Sulphate of Ammonia or "Nitro-Chalk" per acre should be applied during February when such conditions apply. Following this, it is advisable to adopt a normal routine of manurial treatment during subsequent years and to base it upon the need of the trees as exhibited by their condition (see pp. 134–148). In the event of particular deficiencies mitigating against the satisfactory development of the trees, steps should be taken to supply what is needed.

Serious errors are often made about manuring when management is otherwise satisfactory. It is detrimental to apply nitrogenous fertilizers so long as more growth is being made than is desirable. Furthermore, heavy applications of nitrogen should not be given when severe potassium and magnesium deficiencies exist. Special measures are required to correct deficiencies of iron and manganese, the former being dealt with

by the solid injection technique (see p. 277) and the latter either as a spray or by injection (see p. 127).

(4) Pruning.

Neglect in the matter of pruning for a number of years usually results in much crossing, rubbing, overlapping and intertwining of shoots and branches. Such a congestion of material is not so apparent with trees that are stunted as an outcome of tillage and nutritional neglect, because such trees are usually characterised by poor growth and weak, multi-branched spur-systems (see p. 192).

It is easy to do too much pruning where there is much crossing of branches and where their number is really excessive for the space occupied. For trees that are making good growth, it is generally unwise to attempt, during one pruning operation, to correct completely the result of several years neglect, because such a course is likely to be followed by excessive vigour and poor cropping. The first essential corrective measure is a branch-pruning, designed to retain branches for which there is a legitimate place. The term employed for this treatment is " branch spacing," and it involves the elimination of crossing and rubbing. At this stage, the crossing and rubbing of *small* twigs and shoots should be tolerated and only branch material should be dealt with. Sometimes the treatment involves the complete removal of one of a pair of offending branches, at others it will suffice to shorten one of them. The alternative of shortening may be practised when there is enough space for subsequent extension without the possibility of an early recurrence of a similar fault. In addition to dealing with branches that are crossing and rubbing, branch-spacing implies that sufficient space is provided to separate branches so as to allow for the retention of productive side material (i.e. Laterals), also that branches shall not be out of reach, but shall assume a direction which makes for their profitable participation in a tree. This means that very erect, centrally placed branches should either be removed or drastically shortened to an outward growing side branch, also that no pair of branches should be less than 1 foot apart or, if one overlaps the other, nearer than 2 to 3 feet apart. All branches of a tree should be directed outwardly, away from the main stem, and by effecting this, most young growth will be formed in places where it can be usefully employed. Furthermore, branches should give sufficient clearance to allow for cultivations.

For trees that are not stunted, and for which the essential

branch-spacing involves the removal of several branches (say more than one-quarter ot the total tree surface) no further pruning should be done as a first renovation treatment. Other treatments which may appear, in some respects, to improve appearances are likely to result in increased vigour. Future pruning treatments should follow the recommendations for trees which have been subjected to good management (see pp. 160–199). Nevertheless, in one respect the trees may be different: numerous young shoots are likely to be formed direct from old branches; these shoots are commonly referred to as " sucker wood " or " breast wood." Sucker wood that is erect and tall and is unsuited to serve as a productive lateral or to be introduced as new branch-forming material, should be sawn out from the base.

The stunted tree requires some branch pruning and a considerable amount of detailed pruning. Tall, weakly branches should be dehorned and shortened to positions from which young shoot growth would be most aceptable (see p. 192). The detailed treatment consists of removing most of the spurs. Instead of retaining spur-systems with many spurs, they should be reduced so that each carries no more than one or two spurs.

There are two common faults, not so much the result of neglect as of wrong assessment of the pruning requirements either of a particular variety or of trees in a particular state of growth. One fault is where too much pruning is done for trees that are growing with excessive vigour. The other fault is where too little pruning is done for trees that are lacking in vigour. Both extremes adversely affect productivity and they should be regarded as neglect in the sense that renovation and restoration to a higher standard of productivity are rendered necessary.

The pruning of the overpruned, excessively vigorous tree should be such that a lot of the young one-year-old wood is left unpruned. Since it is probable that most of the one-year shoots arise from stubs (see p. 185) of which there are often dense clusters, some sorting out or spacing will be necessary. Young shoots, like branches, require adequate space to afford freedom from rubbing, crossing and excessive shade; to achieve this, it may be necessary to remove completely many shoots and stubs. Erect stubs giving rise to vigorous shoots should be eliminated, leaving by preference, only those that fan out sideways. At the tree tops there are usually many vigorous erect shoots, and a number of them should be retained as leaders and left unpruned for the purpose of extending the

existing branches. The selected leaders should be directed outwards, away from the central part of the tree. They should be spaced at more or less regular intervals and should not be nearer one another than 12 inches for small sized trees, or 2 feet for large sized trees (see p. 183). All other erect-growing shoots neighbouring the leaders should be eliminated, except outward growing side shoots; if such are not rubbing or crossing other branches or shoots, they should be left unpruned. Leading shoots may be shortened when trees are not tall enough and when an increase in the number of branches is required.

Trees that have made too few one-year shoots, because of a deficiency of pruning, demand a severe curtailment of blossom-yielding material; this is made by reducing spur systems so as to leave them as single spurs. Such one-year wood as there is should, so far as is possible, be left unpruned. Leaders should be shortened and tall, weakly branches should be dehorned as stunted trees are treated (see p. 183). Thus while the treatment is designed to reduce the blossom-bearing material, it is also intended to secure a relative increase of the leaf-bearing material. Such a provision will go a long way to facilitate a more vigorous condition. Nevertheless it should be borne in mind that the main instruments for securing a satisfactory state of growth are normally supplied by tillage and manuring.

(5) **Overcrowding.**

It has already been stressed that branches and shoots need adequate space, in order to become efficient members of a tree. The same applies to entire trees, if they are to be efficient members of an orchard. Not only on the grounds of tree performance is adequate space necessary, but also because of management factors. A tree should be well supplied with light from the sides as well as from overhead in order to be an efficient cropping unit. It is also essential to be able to spray, cultivate and harvest crops with relative ease. Hence when management is difficult due to the proximity of trees, a proportion of them should be eliminated (i.e. grubbed) (see p. 251). This treatment is needed especially when the planting space is fully occupied and when the only gain in size can be made at the tree tops.

Growers are sometimes tempted to defer grubbing until it is more than obvious that there is nothing to be gained and much to be lost by retaining all as originally planted. Hence when trees are too crowded, a very common procedure is to allow some trees to retain their full spread and to remove or shorten

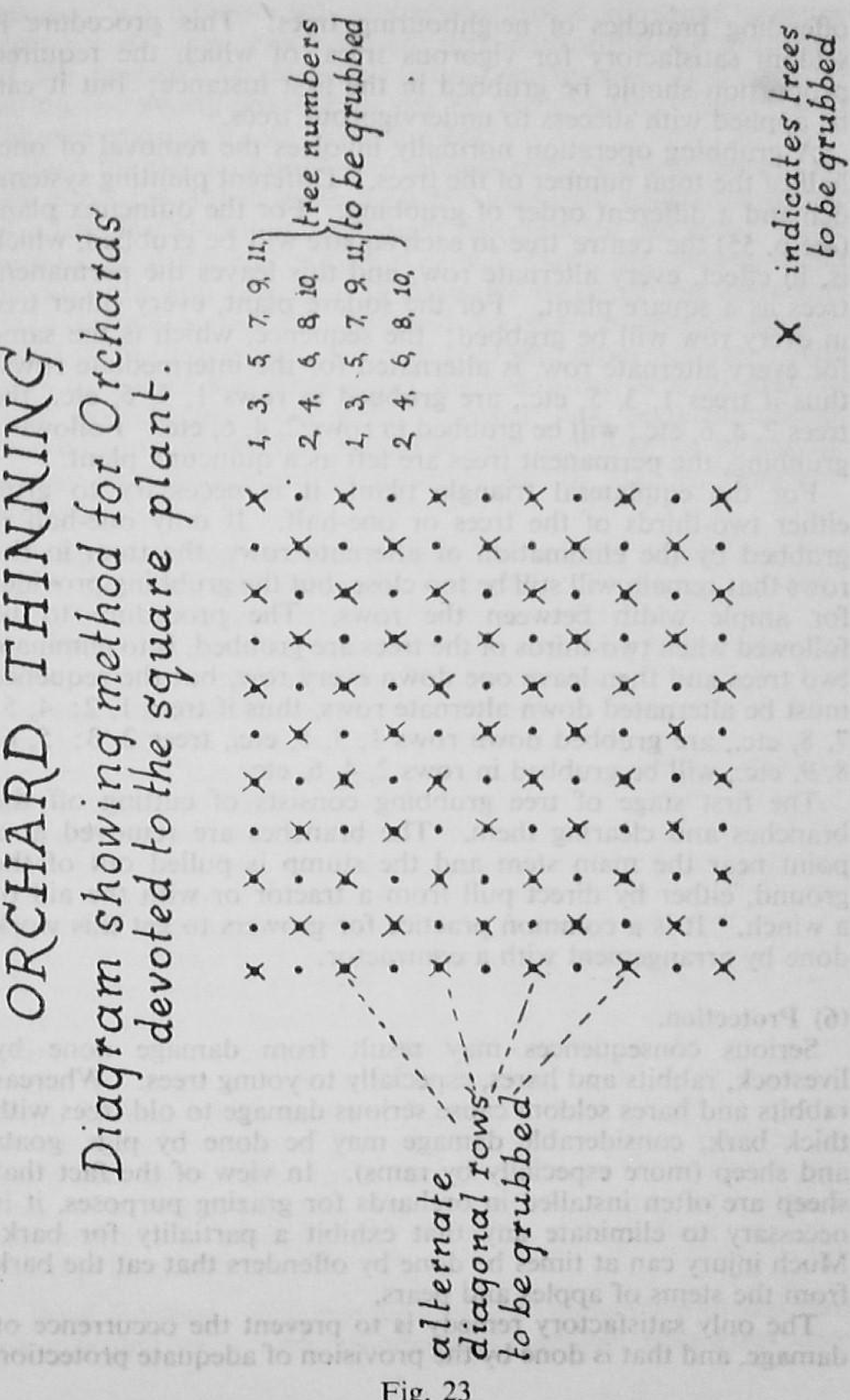
ORCHARD THINNING
Diagram showing method for Orchards devoted to the square plant.
1, 3, 5, 7, 9, 11,
2, 4, 6, 8, 10,
1, 3, 5, 7, 9, 11,
2, 4, 6, 8, 10,
tree numbers to be grubbed
X indicates trees to be grubbed
alternate diagonal rows to be grubbed

Fig. 23

offending branches of neighbouring trees. This procedure is seldom satisfactory for vigorous trees, of which the required proportion should be grubbed in the first instance; but it can be applied with success to undervigorous trees.

A grubbing operation normally involves the removal of one-half of the total number of the trees. Different planting systems demand a different order of grubbing. For the quincunx plant (see p. 55) the centre tree in each square will be grubbed, which is, in effect, every alternate row, and this leaves the permanent trees as a square plant. For the square plant, every other tree in every row will be grubbed; the sequence, which is the same for every alternate row, is alternated for the intermediate rows; thus if trees 1, 3, 5, etc., are grubbed in rows 1, 3, 5, etc., the trees 2, 4, 6, etc., will be grubbed in rows 2, 4, 6, etc. Following grubbing, the permanent trees are left as a quincunx plant.

For the equilateral triangle plant, it is necessary to grub either two-thirds of the trees or one-half. If only one-half is grubbed by the elimination of alternate rows, the trees in the rows that remain will still be too close, but the grubbing provides for ample width between the rows. The procedure to be followed when two-thirds of the trees are grubbed, is to eliminate two trees and then leave one down every row, but the sequence must be alternated down alternate rows, thus if trees 1, 2: 4, 5: 7, 8, etc., are grubbed down rows 1, 3, 5, etc., trees 2, 3: 5, 6: 8, 9, etc., will be grubbed in rows 2, 4, 6, etc.

The first stage of tree grubbing consists of cutting off the branches and clearing them. The branches are removed at a point near the main stem and the stump is pulled out of the ground, either by direct pull from a tractor or with the aid of a winch. It is a common practice for growers to get this work done by arrangement with a contractor.

(6) Protection.

Serious consequences may result from damage done by livestock, rabbits and hares, especially to young trees. Whereas rabbits and hares seldom cause serious damage to old trees with thick bark, considerable damage may be done by pigs, goats and sheep (more especially by rams). In view of the fact that sheep are often installed in orchards for grazing purposes, it is necessary to eliminate any that exhibit a partiality for bark. Much injury can at times be done by offenders that eat the bark from the stems of apples and pears.

The only satisfactory remedy is to prevent the occurrence of damage, and that is done by the provision of adequate protection

(see p. 65). Readers will appreciate that it is unwise to prune trees the stems of which are not protected whilst sheep are still in the orchard because that would encourage them to start eating the young wood as it lies on the ground. The bark of cherries seldom, if ever, attract them.

Bark injuries sustained on one side only of a tree, and so do not affect the whole stem, normally heal over within the course of a few years without permanent detriment to the tree. When damage is done and whilst it is still fresh, i.e. before it has become dry and brown, it is advisable to cover the wound by tying a sack round the damaged portion, to prevent the sap wood from drying out; this will facilitate rapid healing. With trees that have sustained injury all round the stem so that the bark connecting roots with branches has been completely severed, it is more than probable that they will die unless the wound can be bridged by artificial means, viz. by "bridge" grafting.

Bridge Grafting is done during March and April at a time when the bark will lift easily away from the wood. Sturdy, one-year shoots, preferably of the same variety, sufficiently long to bridge the damaged stem and fix to healthy bark tissues on either side, are employed for bridge grafting. The method of dealing with grafting-wood before grafting, is dealt with later (see p. 269). A bridge-graft straddles the damaged portion of the stem and the two ends are fixed by the grafting technique into undamaged bark, so that it can form a conductive channel. A long, sloping, wedge-shaped cut is made at each end of the graft and these are pressed underneath the bark at positions where appropriate knife-cuts have been made to make the operation possible. Similar "L" shaped knife-cuts will be made on healthy bark on each side of the bridge, but the lower one will be inverted (⅂ thus). In the case of thick-barked trees, it is advisable to bevel the bark at the point of entry of the graft (i.e. at the corner of the knife-cut where the two arms make an angle of about 270 degrees). For thick-stemmed trees, several bridge grafts are needed, they should be spaced about 4 inches apart. The grafts are secured in position by tying with raffia. The raffia ties should cover the knife wounds that have been made and then each graft should be sealed in this position by painting over the raffia with grafting wax or a suitable bitumastic paint.

Wind Rocking. Efficient staking for young trees should also be regarded as a form of protection against disastrous con-

sequences that frequently occur as a result of rocking during high winds. Trees with insecure root anchorage are swayed to and fro, and in this way the soil becomes compacted at the sides of a cavity formed by the stem at and below soil level. Such cavities become filled with water during rainy seasons, and denied easy soakage, they often cause the death of roots and stem with which they have contact. Not only is efficient staking necessary, but cavities formed as a result of rocking should be dealt with by forking the soil to bring it into contact with the stem and roots of the trees concerned and to afford easy seepage for water.

(7) Pollination.

Productive crops from any orchard are dependent on fertilization, and this in turn is dependent upon a dissemination of suitable pollen (see pp. 92–107). It is common to find orchards that are not well provided for in this respect and in consequence only poor to average crops result. Pollination should be held in suspect when plantings of single varieties, well managed in respect of spraying and cultural operations, blossoming profusely, and well situated, fail to yield good average crops. The only satisfactory solution is the introduction of a suitable pollinator variety. One of the most convenient and quickest ways of doing this is by "Head-Grafting" a small proportion of the existing trees; i.e. by dispensing with most of the head of the existing variety and growing in its place a head of a pollinator sort. Even after the actual grafting is done, a few years must of necessity elapse before enough blossom is yielded to provide effective pollination.

Head-Grafting. Of the many methods of head-grafting some involve dispensing with most of an existing tree and others make it possible to retain a fair proportion of the main branches. The latter methods take more time but have the advantage that pollinator trees are more rapidly established. The grafting methods described below may be done from February until the end of April, provided the condition of the scion wood is satisfactory. The collection and care of wood in readiness for the grafting operation is the same as described for the Whip and Tongue method of grafting (see p. 269).

Oblique Cleft Grafting. Initially trees should be prepared in readiness for grafting during the Winter and the procedure will depend upon the method of grafting chosen. Some growers

prefer to complete the grafting operation quickly, using only a few scions per tree, in which case the entire head of a tree to be grafted is removed, leaving only the main stem and short lengths of the principal branches. When the branches are thick ones, say more than 5 inches in diameter, it is advisable to sever them further from the main stem where they are not so stout. Care should be taken to remove branches without tearing the bark and in order to do this, it is generally necessary to saw well into the wood on the underside of the branch first.

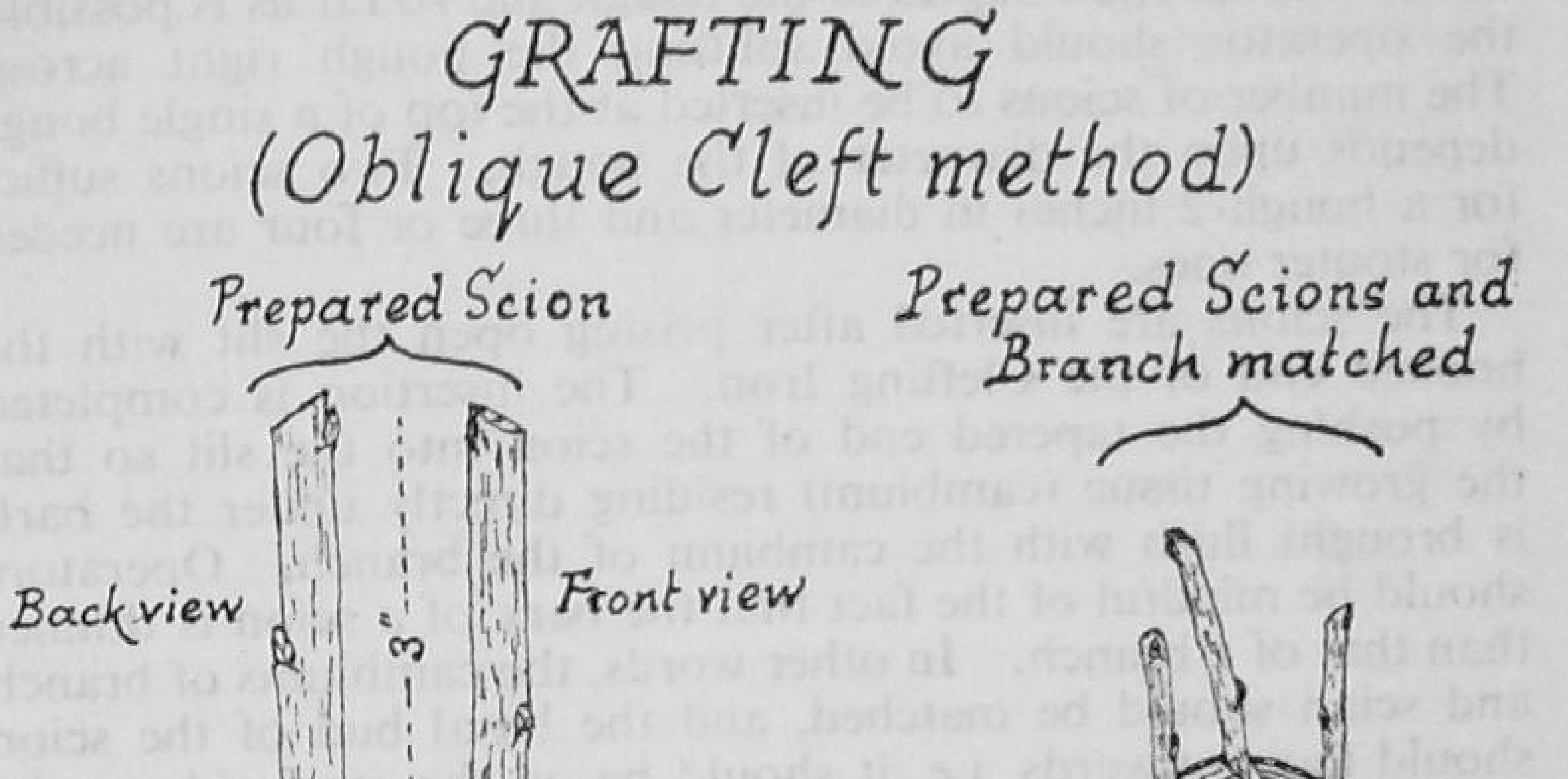

Fig. 24

For boughs more than 2 inches in diameter, the method of grafting known as the " Oblique Cleft " is the best to employ. Scions about 3 to 4 inches long are used and these are tapered

at the base by cutting on opposite sides of a basal bud to form a wedge.

The final preparations of a branch in readiness for inserting the scions consists of removing, by saw, a few inches from the extreme end at a point free of knots. Some favour smoothing the saw cut over with a sharp knife. The axe end of a Clefting Iron is then employed to make vertical slits, shallow, yet deep enough to receive the scion. With stout boughs more than 2 inches in diameter, the Clefting Iron will be held obliquely rather than at right angles to the bough and so far as is possible, the operator should avoid splitting the bough right across. The number of scions to be inserted at the top of a single bough depends upon the diameter of the bough. Two scions suffice for a bough 2 inches in diameter and three or four are needed for stouter ones.

The scions are inserted after prising open the slit with the hooked end of the Clefting Iron. The insertion is completed by pushing the tapered end of the scion into the slit so that the growing tissue (cambium) residing directly under the bark is brought flush with the cambium of the branch. Operators should be mindful of the fact that the bark of a scion is thinner than that of a branch. In other words, the cambiums of branch and scion should be matched, and the basal bud of the scion should face outwards, i.e. it should be on the same side as the matched cambiums (see p. 255). Upon removing the clefting iron the scion is held firm. All exposed cut surfaces and crevices resulting from the grafting operation should be sealed over with grafting wax, immediately after the grafting operation.

Some varieties of apples such as Early Victoria (Syn. Emneth Early), Grenadier, Newton Wonder and Beauty of Bath, and also several plum varieties and cherry varieties are not good subjects for the head-grafting method just described. This is mainly on account of the high percentage failure caused by diseases such as Silver Leaf (see p. 234) and " Papery Bark."

Side Grafting and Stub Grafting. When a considerable part of an existing branch system is retained, two simple forms of Cleft grafting, viz. Side Grafting and Stub Grafting, may be employed to furnish trees with scions. A tree is prepared for the operation by removing all maiden shoots and spurs and spur systems, stout side branches, the top portion of each branch at a place where they are about 1½ inches to 2 inches in diameter and all very slender wood. Other material, viz that ranging from ½ inch to 1 inch diameter at the base should be retained or shortened to leave it 6 inches or more long. A tree

is thus stripped of all material, except a skeleton of framework branches and small side branches of stated thickness; it is necessary that these small side branches should make a wide angle with the branch from which they originate. It will be found that some of the main branches will be well furnished with small side branches, whereas others are rather bare in this respect. For the barer type, scions are inserted direct into the sides of the branch, as well as one at the top. The method is conveniently referred to as "Side Grafting." Where possible, scions are inserted at the base of the small side branches, and when this is done only a tiny stub of the side branch is retained. This method is referred to as "Stub Grafting." A branch may also be conveniently terminated with a stub graft. It will be appreciated that in many instances, it may be advisable to employ both methods of grafting on one and the same tree.

Scions 6 inches to 8 inches long may be employed, and indeed they are better than shorter ones. At the base of each scion, two slanting knife-cuts are made to form a wedge, this wedge should be more tapering for side grafting than for stub grafting. As for Oblique Cleft Grafting the wedge should be formed on either side of a basal bud.

Side grafts are inserted into clefts, i.e. slits in the side of a branch. A slit is formed by making a transverse cut at an angle of about 20 degrees through the bark, penetrating the wood to a depth of about 1 inch. Care should be taken not to penetrate too far across a branch, say more than one-third of the diameter, as this would result in structural weakness. A single scion is pushed tight into each slit, keeping it to one side in order that the cambium tissue of the scion and branch are brought to lie alongside one another.

A stub graft is inserted into a cleft made at the base of a small side branch. A cleft is formed by pressing the blade of a knife into the side branch on the upper side, commencing about ½ inch from the main branch. By holding the knife at an angle of about 30 degrees, the blade is pressed forward to come to rest in the main branch, and the operation is helped by bending the small side branch downwards. The knife blade should not penetrate deeper than the centre of a side branch, or, otherwise, the cleft so formed would not hold the scion firmly, if indeed the side branch is not actually broken in the process.

A scion is pushed into position whilst the cleft is held open by bending the side shoot downwards and it is gripped firmly when the downward pressure is released. Close cambail

GRAFTING
(Stub and Side Method)

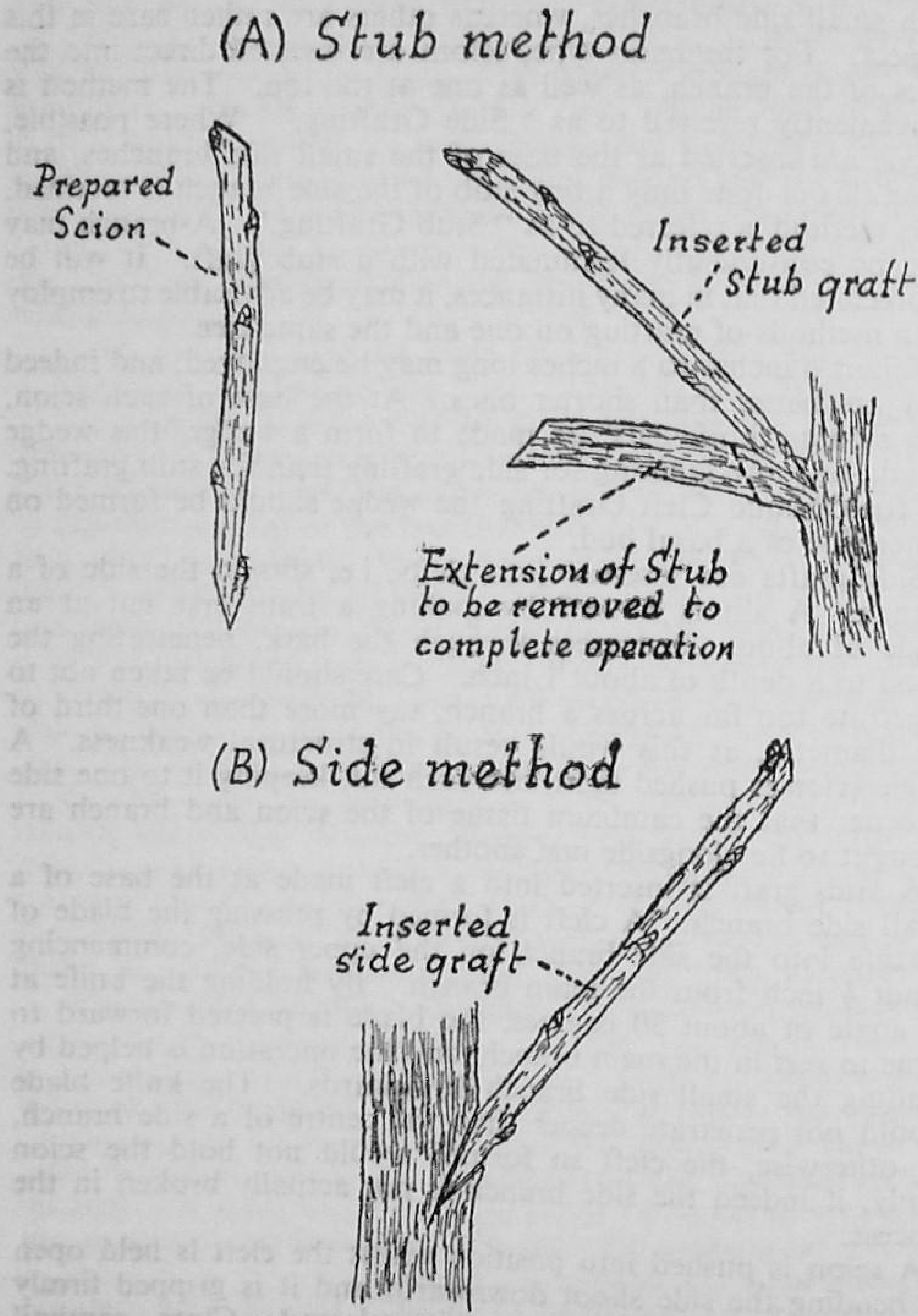

Fig. 25

relations between the scion and the cleft are essential, as in the case for other forms of grafting (see pp. 256, 271). Having inserted a stub graft, the portion of the side shoot extending beyond the base of a scion should be removed, an operation which is best done directly before sealing all cut surfaces with grafting wax.

Some consideration should be given to spacing stub or side grafts at regular intervals on each side of a branch. A suitable distance apart is 1 foot, alternating on each side of a branch, avoiding placing them in positions so that they directly overlap. Each branch should be terminated with a scion. It is preferable to insert too many scions than too few, for such a procedure gives additional insurance to the success of the operation, and any that are surplus to requirements can be removed at a later date.

Subsequent Treatment of Head-Grafted Trees (Pruning).

All shoot growths of the parent variety should be removed. Suitable branch-forming shoots should be selected and shortened at positions where new shoots are needed for the formation of branches. The considerations for the selection and pruning of such shoots are the same as for normal trees (see p. 183). When head grafting by the Oblique Cleft method has been done and where more than one scion has been inserted at the top of a single branch, only one, actually, of the scions is required to provide branch extension and multiplication. After a few years the surplus scions will be completely removed, but not until the one chosen for branch extension is stout enough to support the entire parent branch. Until this time the surplus ones should be kept small by shortening them severely each year. When branches are formed fiom more than one scion at the top of a single bianch, breakage often results from subsequent increases in stem diameter of the original scions. In other respects the pruning is as for normal trees (see pp. 173–199).

(8) Drainage.

There are strict limitations to the improvements possible when the main cause of poor orchard conditions is due to faulty drainage. Where conditions of excessive Winter wetness and severe Summer drought exist together on an extensive scale it is to be doubted whether effective remedial measures are merited (see pp. 35, 36).

Where localized conditions of impeded drainage exist, benefits may be obtained over the affected areas by the installation of

a pipe drainage system, or by mole-plough draining in the case of clayey soils. Similarly, benefits may be obtained on localized drought spots by surface mulching during February with bulky organic manures, and in other cases by irrigation.

With borderline soils possessing adequate depth, where drainage conditions have been allowed to deteriorate due to neglect in cleaning ditches, the beginning of improvement is achieved by cleaning them out to provide facility for the movement of drainage water. Under such conditions a pipe drainage system is of value, and for soils of a heavy clay type periodical mole-plough draining is advantageous.

(9) Gaps, Age and Variety.

Neglect, disease or accident may result in the death of trees and thus give rise to gaps in an orchard. The question arises as to whether it is an economic advantage to plant young trees in the gaps, a practice spoken of as "Gapping up." Three main considerations should be taken into account, viz. (i) Cause of Gap, (ii) Age of Orchard, (iii) Varieties.

(i) Cause of Gap. It is unsatisfactory to do any gapping up when the previous cause of failure was adverse soil factors, such as poor drainage or shallow soil; it would merely invite repetition of the failure. A policy of gapping up is sound, provided that the neighbouring trees are not old ones and there is reason to believe that the young trees will not be long in forming good heads. Young replanted trees by the side of big trees are slow to form good heads and so are those planted direct into grass orchard conditions.

(ii) Age of Orchard. The practice of gapping up old orchards is not to be commended. It should be borne in mind that young trees take several years to gain reasonable size when planted in between old trees, much longer than when similar trees are planted on open land. In view of this, satisfactory crops from them cannot be expected for some long period, even when they are favoured with good management, extra cultivation and manure. By the time that the young trees actually commence cropping, which may be anything from eight to fifteen years, the established plant will be that much older, and the value of the orchard, as a whole, may quite well be on the decline (p. 243).

For plums, it is doubtful whether gapping up is merited after the original trees have been planted more than 10 to 12 years, for apples and pears more than 15 to 20 years, and for cherries more than 20 to 25 years. Where old orchards are concerned,

it is preferable to grub a specified acreage every year, and every few years to plant up an equivalent acreage of young trees, rather than indulge in gapping up every year. By following this procedure, old orchards give place to young ones with the least possible delay and with most satisfactory advantages for management.

(iii) Varieties. As a general rule, gapping up should be done with the same variety as the main plant. The temptation to introduce other varieties, except in special cases (e.g. where pollinator sorts are required) should be resisted, as their introduction is only likely to add to future management difficulties. If it is contended that the main plant is not an economic sort to grow, then the alternative of grubbing or head-grafting to a more economic sort should be contemplated. When head-grafting is done, suitable provision for pollinators should be made (see p. 254); otherwise the same sort should be chosen for gapping up as for head-grafting. It is not enough to know that a sort has good market value, since no variety is capable of justifying commercial existence unless it is planted on a sufficient scale to cater for the needs of its management economically. With cherries, however, where the main plant should consist of several sorts, varietal considerations do not apply to the same extent as for apples, pears and plums, provided pollination requirements are satisfied. Nevertheless even for cherries the moving of ladders for harvesting should be considered and the varieties chosen for gapping up should be sorts that are harvested at the same time as those in the immediate neighbourhood.

APPENDIX II

PROPAGATION

THE REPRODUCTION OF FRUIT TREES, BUSHES, CANES AND PLANTS.

Unlike the agriculturist, who sows seeds for the production and reproduction of various crops, the fruit grower has to resort to vegetative methods of reproducting the various kinds and varieties of fruit. For this reason most fruit growers prefer to purchase their requirements from nurserymen who specialize in the raising of young fruit trees, bushes, canes and plants. Seed sowing for the raising of fruits must be confined to production of new varieties and, to a limited extent, for the production of rootstocks (p. 82). Seedling fruits are generally very different from the parent varieties and in no sense can they be relied upon for the production of named varieties.

It is hardly to be expected that fruits which vary so much in character and appearance as these under consideration will lend themselves equally well to the same method of vegetative reproduction. Several methods are in fact employed to raise the various kinds of fruit.

For blackcurrants, redcurrants and gooseberries, short pieces of one year old wood, called " cuttings " taken from the parent bushes during Autumn and Winter readily form roots and shoots when planted in favourable (i.e. deep fertile) soil and from these young bushes can be formed. Similarly, short pieces of one year shoots may be taken from apples, pears, plums and cherries, but since these would seldom root of their own accord they are fixed, after making appropriate knife cuts onto young trees already provided with a root system. Rooted trees employed for this purpose are commonly known as root-stocks and the cuttings that are fixed on to them as " grafts " or " scions " (see pp. 80, 269). Although the " grafting " technique is a popular method of raising fruit trees, it is more usual to raise apples, pears and plums by the " budding " method. Whereas grafting is done during late Winter and Spring, budding is done during Summer and consists of taking a single bud from a leafy shoot and fixing it beneath the bark of a rootstock.

Loganberries and blackberries are reproduced by embedding the tips of young shoots in the soil whilst they are still attached to the parent plant. This procedure is normally referred to as "layering" and the resultant young plants are "rooted tips." The rooted tips are severed from the parent plants during Winter, after which it is the customary practice to grow them on for a year before they are planted out under plantation conditions for fruiting purposes.

Such fruits as raspberries and strawberries increase in number on their own account. Young canes are formed during the Spring and Summer months by established raspberries and these can be dug up, together with a piece of root attached to each and planted out during Autumn and Winter. In the case of strawberries, young trailing stems (i.e. stolons) are formed by parent plants and these give rise to young plants, spoken of as "runners." These stolons are severed immediately prior to lifting young plants that are to be planted out, during Autumn or Spring.

Some details are given below of nursery technique for growers who wish to raise fruits for themselves.

CUTTINGS.

Blackcurrants.

One year old shoots are taken from healthy (see p. 213) bushes during Autumn and Winter and these are cut into lengths about 9 inches long, to produce the cuttings. Each cutting should begin with a bud and be terminated by a bud. The cuttings should be pushed into the soil, preferably a deep, fertile, sandy loam and only one or two buds should be left showing above soil level. The individual cuttings should be spaced about 6 incher apart in straight rows and the rows should be about 2 feet apart. Cuttings should be planted firmly, and if frost tends to lift them they should be pressed down and trodden firm again. The majority of main branch-forming shoots of a young blackcurrant bush should be formed from below soil level, hence the reason for leaving only one or two buds of a cutting above soil level. When shoots are formed at the top of a stem above soil level, the vigorous growth required for productive bushes is seldom obtained.

Redcurrants and Gooseberries.

Like the blackcurrant, cuttings from these fruits are made from one year old wood, but they should be from 12 to 15 inches long. It is the usual practice to remove all the buds

from each cutting with the exception of three or four at the top. The method of planting and spacing in the cutting bed is the same as for blackcurrants, excepting that about 6 inches of each cutting should be left visible above soil level.

Most fruit growers prefer gooseberries and redcurrants to have a short stem. At its top, shoots are produced from which the head of the bush is formed. For this reason, the lower buds are removed, longer cuttings are employed than for blackcurrants and they are left standing taller above soil level. The preference for bushes with a short stem depends upon the fact that somewhat less vigorous growth is required than for blackcurrants, and that clean cultivation is easier to maintain; furthermore, the spreading habit of most gooseberries makes a stem desirable. Nevertheless for redcurrants some favour the " stool " type of bush as grown for blackcurrants.

RUNNERS.

Strawberries.

It is essential that strawberry plants employed for runner production should be healthy, since virus diseases can be responsible for their rapid degeneration and the nature of these troubles is such that they are transmitted from parent to progeny (see p. 219). The best source of runners is provided during late Summer to Spring from plants that were planted as runners the previous Autumn or Spring. It is the practice of some growers to allocate a few rows of plants, established primarily for fruiting purposes, for runner production. From these plants runners are allowed to form in between the established rows.

Of recent years, specialist attention has been paid to the raising of strawberry runners, and nursery beds have been established in comparative isolation from fruiting plantations. A method of doing this is to plant the parent runners at 3 feet by 3 feet apart. During the Spring and Summer months, clean cultivation can be maintained by tractor or horse drawn implements. Cultivations are maintained until July or early August, after which time runners are allowed to form. To begin with runners should not be permitted to grow at random all over the runner-bed, but only in alternate spaces between rows both in the down row direction and the across row direction; thus cultivation can proceed on the parts kept free of runners until about September when the rogueing for eliminating virus disease has been done. In effect, runners are allowed to form in 1 yard squares, served by a parent plant at each corner

and bordered by a gangway on each side. Later on, say during September runners may be allowed to spread over the entire ground. The method allows for the first formed runners to be lifted for Autumn planting and the later ones for Spring planting.

It is the custom to establish a new runner bed every year, because only one crop of runners is taken from parent plants.

ROOTED TIPS.

Blackberries and Loganberries.

The tips of young blackberry shoots form roots much more readily than those of loganberry. The tip (and this can include 2 to 3 feet of a stem from the tip) may either be pegged to the ground or covered with two to three inches of loamy soil during early Autumn. Roots will form both at the tip and along the stem. The tips of young loganberry shoots should be embedded vertically in a slit trench about 6 inches deep. The rooted tips are lifted during Spring and severed from the parent stem. In the case of the blackberry which has formed roots along the stem, short lengths of stem each including some roots and a stem bud may be cut to form the beginnings of a young plant.

It is seldom the practice to establish a plantation with rooted tips newly severed from the parent plants; it is customary to grow them on for a year or two by planting them close together, say 6 inches to 1 foot apart in rows, under nursery conditions.

BUDDING AND GRAFTING.

These are processes by which buds and short stems, taken from the various tree fruits, are fixed on to trees that are already rooted. For head-grafting, big trees may be employed, but for raising new trees, small rooted trees, commonly known as rootstocks (see pp. 80–91), are employed.

BUDDING.

Apples, Pears, Plums and Damsons.

Most budding is done during July and August. New season's shoots of average type, avoiding the very stout or very slender ones, and those from shaded parts, are severed from trees of the kind it is desired to propagate. Immediate upon severance from the trees, the leaves should be removed, but the leaf stalks should be retained. It is important that the severed shoots should not be allowed to get dry or shrivel, and this is the main reason for removing the leaves. If a day or two is likely to elapse before they are used, they should be kept moist with the aid of damp moss, or moistened wood wool.

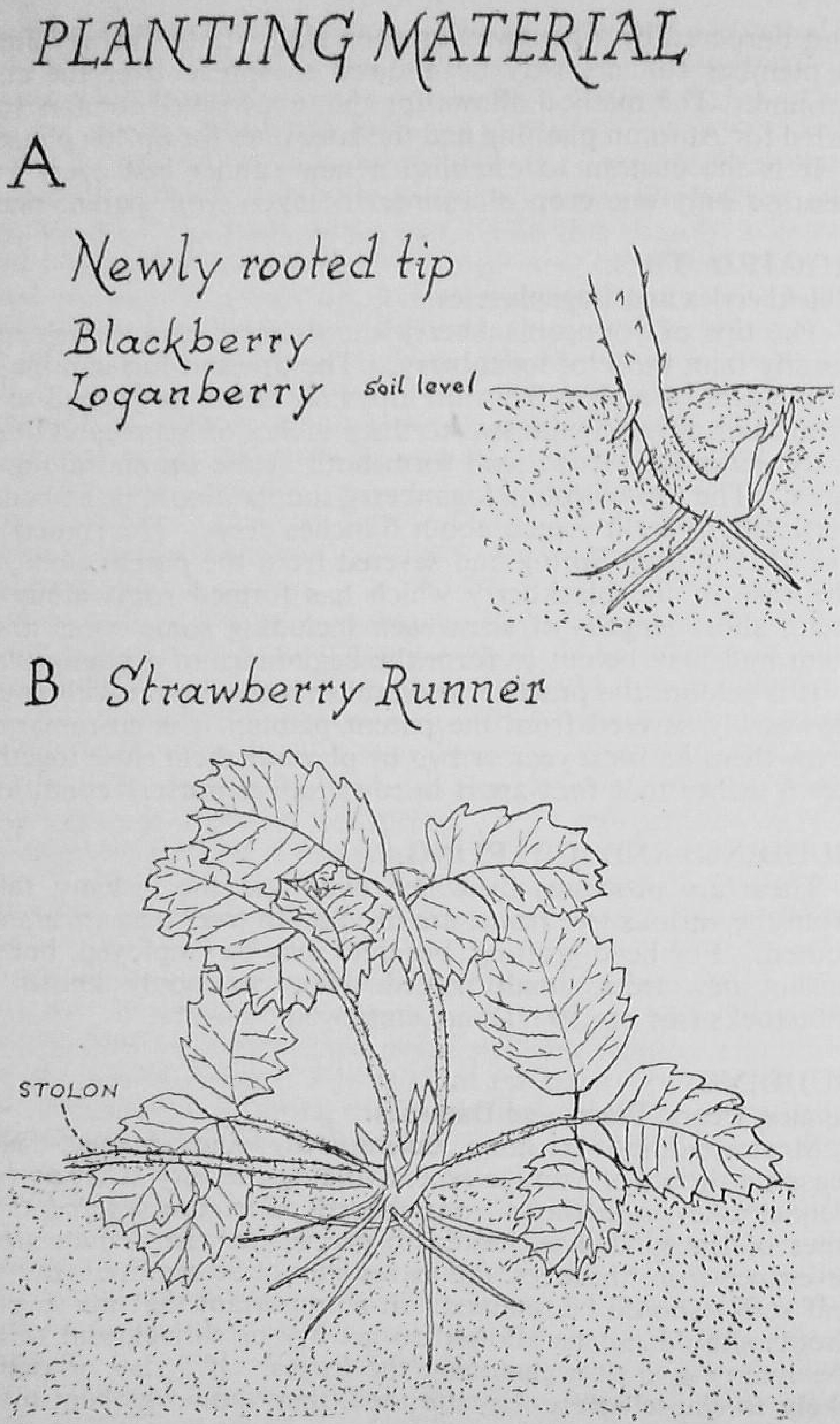
PLANTING MATERIAL
A
Newly rooted tip
Blackberry
Loganberry
soil level
B Strawberry Runner
STOLON

Fig. 26

The actual budding operation consists of removing a single bud from one of the shoots and fixing it beneath the bark of a rootstock. A smooth part of the bark of the rootstock about 4 inches to 6 inches above soil level should be chosen for the insertion of the bud. A single bud, that is the axil of a leaf stalk, is removed from one of the shoots, together with a thin piece of bark. The piece of bark, with the bud in the centre, should be about 1 inch long. When severing the bark and bud from a shoot, it is essential that no injury be done to the bud, and in order to avoid this, some of the woody part of the stem must also be removed with each bud. Some, experienced in budding, peel the piece of wood away from the inside of the bark. This is not necessary so long as the wood is pliable and so will readily bend to the shape of the stem of the rootstock to which it is to be tied.

Two knife-cuts should be made on the stem of the rootstock at the position selected for inserting a prepared bud. One is a horizontal cut about ½ inch long. The cut is only intended to sever the bark and not to penetrate the wood. The second knife-cut which should be vertical and about ¾ inch long is made in a similar manner to the first cut. The two cuts should form a letter T which means that the vertical cut is made directly below the horizontal one and meets it at a point mid-way between its two ends. At the position where the vertical cut meets the horizontal cut, two corners are formed. At these two corners the bark is lifted away from the wood, thus forming an opening between the wood and the bark. The "bud," together with its small strip of bark, is pushed into this opening by taking hold of the leaf stalk, so causing the entire cut surface of the "bud" to lie flush with the exposed wood of the rootstock. Before one can have reasonable expectation that the "bud" will become united to the rootstock and subsequently grow, it is necessary to bind it with raffia or elastic strips. After two or three weeks the raffia strands should be severed with the point of a sharp knife, or otherwise they are liable to strangle the "bud."

Although it is customary to leave the stem of the rootstock standing about 6 inches taller than the inserted "bud," increasing numbers of growers are inclined, during the following Spring, to remove all the portion of the rootstock above the "bud." When the rootstock is left to stand taller than the "bud," the portion of stock above the "bud" is severed during early Summer, but until then it is employed to give support to the newly developing tree. A young shoot is formed

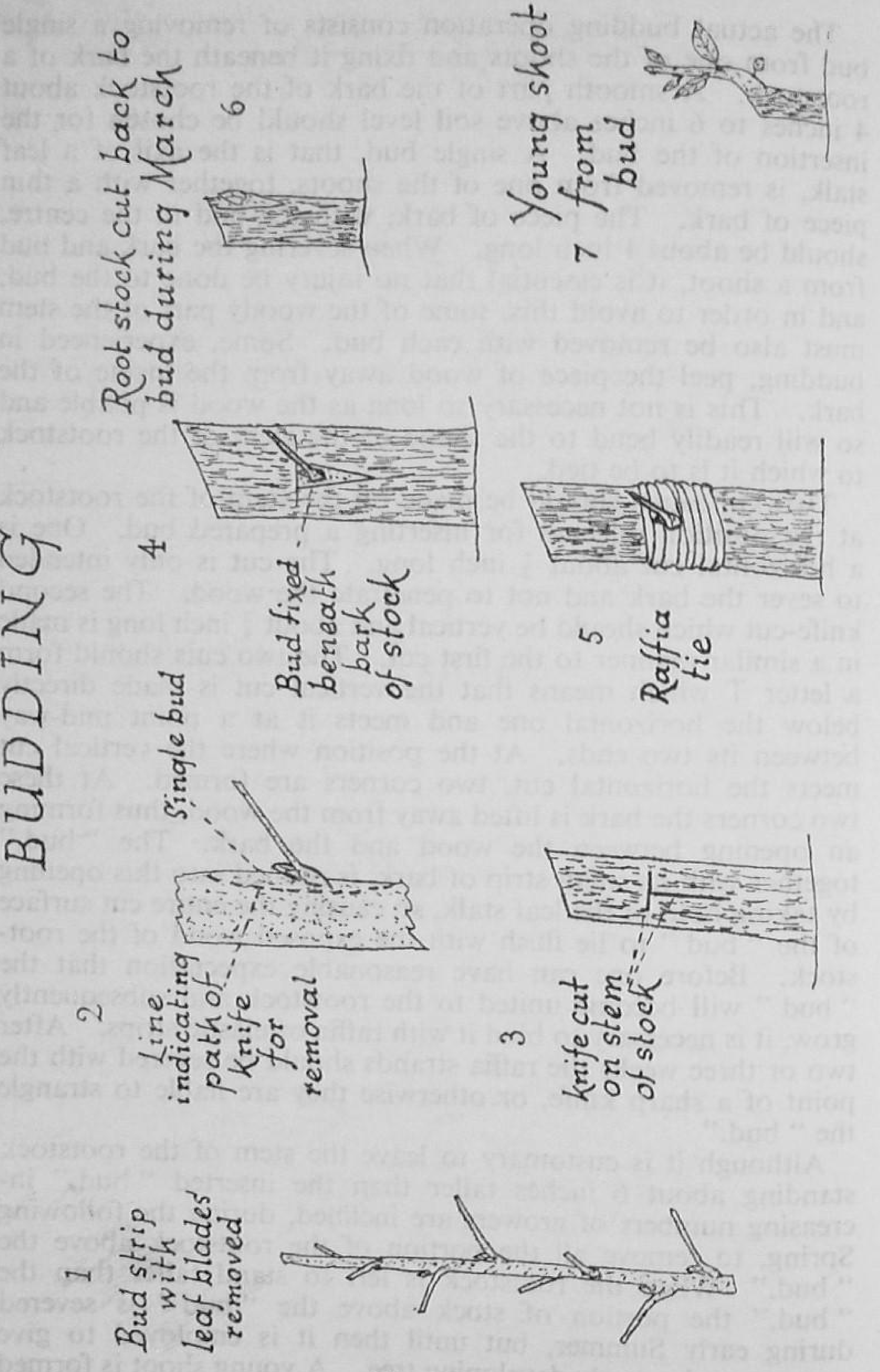
BUDDING
1
Bud strip with leaf blades removed
2
Line indicating path of Knife for removal
Single bud
3
Knife cut on stem of stock
4
Bud fixed beneath bark of stock
5
Raffia tie
6
Root stock cut back to bud during March
7
Young shoot from bud

Fig. 27

from the " bud " and this is tied into an erect position. It is very desirable that young trees with erect stems should be formed, and it is sometimes necessary to provide support for this purpose, some people tie them to bamboo canes and others fix a metal clip which has an erect finger at the base of the " bud." The bamboo cane has an advantage in windy situations. In sheltered situations, no support is needed.

GRAFTING (WHIP AND TONGUE METHOD).
Apples, Pears, Plums, Damsons and Cherries.

Rootstocks for sweet cherries are allowed to grow tall before the chosen varieties are " worked " on to them. They are normally grafted at from 4½ to 7 feet high. Even at this height, the stem should not be slender, but for preference should be about the thickness of one's thumb. The position of grafting has in the past, largely been determined by the fact that mature cherries are usually grown in grass which is grazed by sheep. The present tendency of dispensing with sheep in the cherry orchard, encourages growers to have shorter stemmed trees, say 4 or 5 feet. Where tall rootstocks are employed, varieties are invariably propagated by grafting. Grafting is also employed to make good any " bud " failures on the general run of rootstocks that are " worked " near to soil level. Thus a second chance of securing a tree from a single rootstock is afforded, budding is done during Summer, and if this fails, grafting is done during Spring. It is usual to adopt the Whip and Tongue method of grafting when new trees are being produced, the method being very suited for rootstocks with relatively slender stems. The majority of Whip and Tongue grafting is done during March.

Although the inexperienced can usually obtain better results from grafting than from budding, the latter only yields a single stem which is an advantage when the operation is done near the soil. In grafting, two or more shoots may be formed, since more than one bud is employed for each graft.

Grafting wood (or scion wood), is collected from the parent trees during the Winter; January is a good month. Well-grown one-year-old shoots are chosen for the purpose. Since these shoots are collected before the actual grafting operation is due to begin, they should be kept in a suitably fresh condition by covering the lower portion with soil in a cool place.

The individual graft consists of about 4 to 6 buds and is about 3 to 5 inches long. One method by which it can be made is first to cut a 3 to 5 inches stick from one of the shoots. This

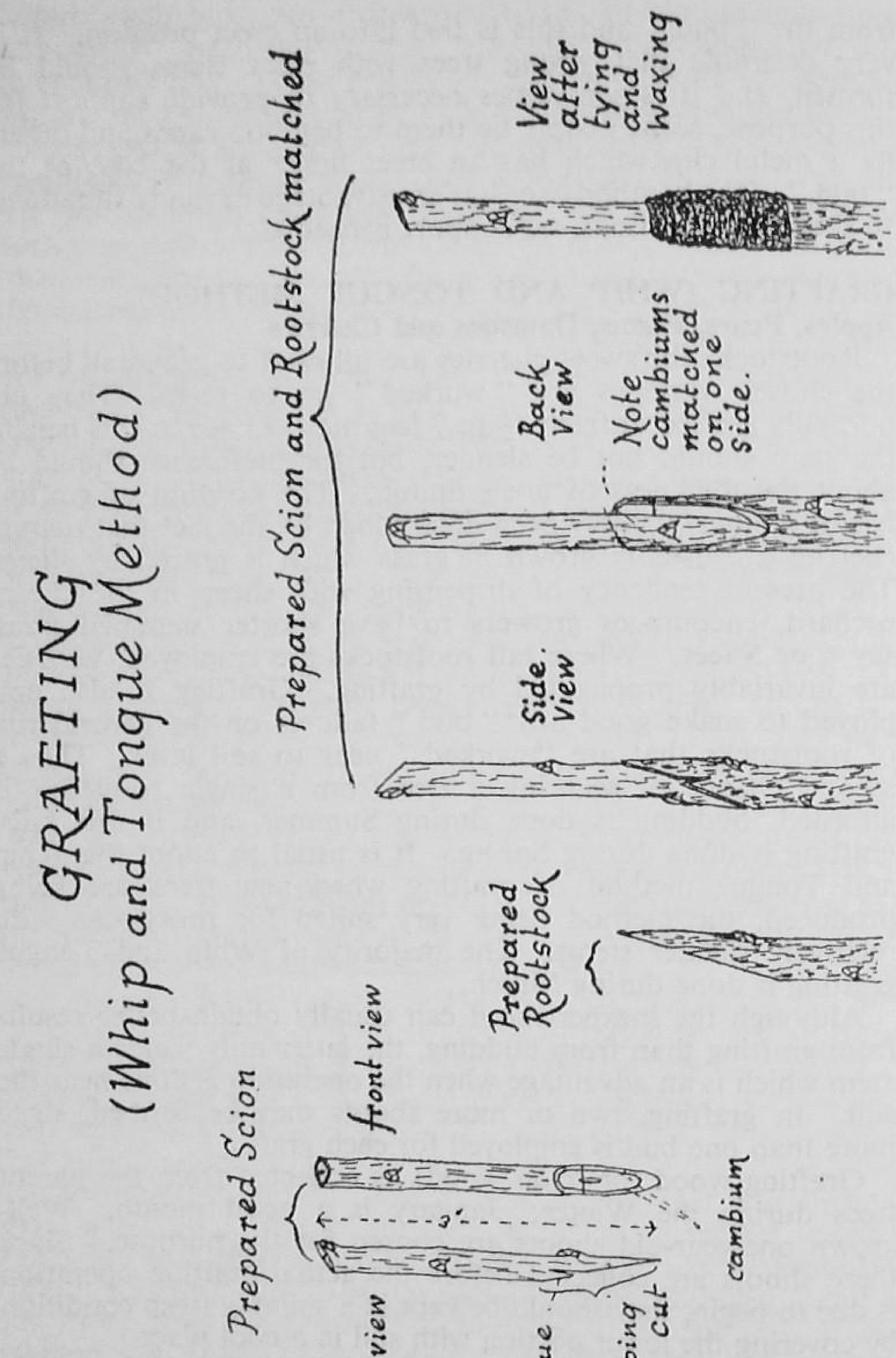
GRAFTING
(Whip and Tongue Method)
Prepared Scion
side view
front view
tongue
long sloping cut
cambium
Prepared Rootstock
Prepared Scion and Rootstock matched
Side view
Back view
Note cambiums matched on one side.
View after tying and waxing

Fig. 28

short stick should be terminated with a bud, and there should also be a bud within about ¾ inch of the base. A smooth, slanting cut about 1 inch or 1½ inches long should be made at the bottom end, starting about 1½ inches from the base, on the opposite side to the lowest bud and terminating at the base on the same side as the lowest bud. At a point about half-way across this slanting cut, the knife is pressed upwards into the wood for about ¼ inch so that a small, tongue-like, or rather tapering, wedge-shaped piece protrudes. This cut surface with its wedge-shaped tongue has to be fitted on to a similar cut surface on the rootstock.

To prepare a rootstock for the reception of a graft, the top is first removed, leaving only 3 or 4 inches when it is being worked near to soil level. When grafting has to be done at half-standard and standard height, 4 feet to 7½ feet of the rootstock will be retained. It should be borne in mind that, in so far as it is possible, a position should be selected for grafting where the stem is smooth, that is free of injury, knots, etc. It is worth while deviating two or three inches from the accepted height, if by so doing, the stem is more suitable for grafting at that point. Having removed the top of the rootstock, a slanting cut should be made to correspond with the one made at the base of a graft. The cut is started at 1 or 1½ inches from the top of the rootstock and terminates at the top. For slender stems of about a pencil thickness, the cut should terminate on the side opposite that at which it started. For thicker rootstocks, since it is preferable to keep the cut surface fairly narrow, the cut will invariably terminate on the same side. One further knife-cut is needed to form a slit to receive the tongue of the graft. This slit is made by holding the blade of the knife across the cut surface, at a point about ¼ inch from the top, and pressing it down into the wood for about ¼ inch.

Clean, smooth cutting is necessary both for graft and rootstock since the two component parts of a tree are required to dovetail into one another. The process of fitting these two parts is all important to the success of the operation. It is well known that the layer of cells known as the cambium, which resides between the bark and the wood is growing cells responsible for the growth of the callus which alone can effect a union between rootstock and graft (p. 256). In fixing a graft on to a rootstock, it is essential that a good portion of the exposed cambium layer of the one should have as near contact as is humanly possible with a good portion of the exposed cambium layer of the other. This means that care must be

exercised to get the inside edges of the graft bark matched so that they come flush with the inside edges of the rootstock bark. Sometimes the cut surface on the rootstock is wider than that of the graft, making it impossible for a complete matching of cambium, in such cases, the inside edges of bark must be matched on one side. For cherries thick scions should be used and the cambiums should be matched on both sides if disappointing results are to be avoided. Whilst observing this rule, a graft is fixed into position by pressing the wedge-shaped tongue into the prepared slit of the rootstock. After fixing in this manner, the two are held firmly by binding them together with raffia and they are prevented from drying out by painting with grafting wax over the raffia and all exposed cut surfaces. Since there is more than one bud on each graft, it is highly probable that more than one shoot will be formed during the growing season. For low "worked" rootstocks, only one of these shoots is required to form the stem of a tree; hence the most suitable shoot is allowed to grow and it is often tied to a bamboo cane for support. The remaining shoots should be prevented from growing tall by pinching out the growing point whilst they are still young and tender; subsequently these shoots are removed in their entirety. In order to prevent the raffia from strangling the graft, as both it and the rootstock thicken, it is necessary to sever the strands with the blade of a knife, say during June or July.

When the actual rootstock forms the stem of a tree and the grafting is done at the top, the shoots formed by the graft are not limited to one, but all are permitted to grow.

Young shoots are sometimes formed by the rootstocks, either from the base of a tree, at or below soil level, or from the stem. All such shoots should be entirely removed before they have made much growth.

The use to which grafting can be put by the fruit grower is not limited to the production of young trees. Grafting may also be employed with established trees to change them over from one variety to another. Methods such as Cleft grafting of various forms or Rind Grafting are generally used for this purpose. The commercial application of changing varieties by grafting is dealt with in Appendix 1 dealing with Orchard Renovation (pp. 254–259).

APPENDIX III

HARVESTING, STORAGE, MARKETING

Post-production management does not come within the scope of this book for detailed consideration. Nevertheless it is fitting to indicate what is involved once crops have been produced.

The most exacting period in the administration of a fruit farm is the harvesting period. Fortunately all fruits do not reach picking maturity at the same time, and a judicious selection of kinds and varieties serves to ease harvesting problems (p. 41). No matter how well the planning is done in this respect, the general trend is to favour certain kinds, e.g. Cox's Orange Pippin apple and to plant as many as the soil conditions permit (p. 39), and reserving only the soil unsuited for the most favoured sorts for kinds that can be depended upon to succeed. Harvesting and marketing are the costliest items in connection with production; this, coupled with the fact that there is only a limited period over which any crop can be gathered, serves to stress the need for an adequate labour force, efficient organization and reasonable accessibility.

It is customary to pay labour for fruit picking on a piece-work basis, at so much per lb. or bushel, or whatever measure is used. The piecework rate adopted differs considerably, according to the kind of fruit, estimated weight of crop and other factors tending to make harvesting relatively easy or difficult. It is necessary to fix a piecework rate that ensures that the slowest workers will not earn less than when paid at the normal day rate. Piecework harvesting necessitates super-vision to ensure both that picking is thorough and that the fruit suffers a minimum of spoilage in the process.

SOFT FRUITS.

When soft fruits are harvested for the open market to be sold in shops, they should be picked direct into the container in which they are to be despatched. When the fruit is intended for despatch to the processor, trays, tubs or other containers are normally supplied by the processor into which it is emptied directly after picking.

Most soft fruits are marketed in non-returnable chip baskets. For strawberries, raspberries and blackberries, 1, 2 and 4 lb. sizes are normally employed. As a rule, the dearer and softer the fruit, the smaller the container that is used. For gooseberries, black and redcurrants, 4, 6, and 12 lb. sizes are most popular. Gooseberries that are harvested before they are ripe for culinary purposes are often despatched in returnable wicker baskets supplied by the salesmen and referred to as half-sieves.

Various field facilities are needed for weighing, cover against direct sunlight, rain or dust; also accessibility for carrying the fruit away by lorry. Some growers are content to cover with tarpaulin sheets as the need arises, whereas others have lightly constructed erections on a dutch barn principle, covered for the season by a tarpaulin sheet.

TREE FRUITS.

The employment of light, three-legged steps or ladders is generally necessary when harvesting tree fruits. Well-planned orchards are designed to facilitate the operation (p. 53), and such factors as concentration of varieties and roadways to afford accessibility and so reduce carrying by hand to a minimum are of great importance.

As with other fruits, considerable injury and consequent loss of value can result from careless picking. Heavy handling results in bruises, long finger nails cause skin punctures and direct pulling causes loss of stalk; all these should be reduced to a bare minimum. Skin punctures provide entry for fungal rots, especially for Brown Rot (p. 235) and they result in much needless wastage. Picking of apples and pears should be done by lifting the fruits; if this is done with a slight twist, it invariably results in cleavage at the abscision point at the base of the stalk.

Cherries, plums and damsons, whilst picked in baskets or buckets to which hooks are attached, are marketed in half-sieves. High-class dessert plums are despatched in chip baskets, usually of the 12 lb. size. For apples and pears picking is done into padded baskets, buckets or picking bags, which are emptied into orchard boxes. A variety of containers is employed for despatching fruit to market, because the different varieties yield fruits of different sizes and values. Packages range through the Standard Apple Box, the half-box, sieve, half-sieve, tray, barrel and orchard box.

Several factors contrive to give increasing popularity to the non-returnable standard apple box and half-box, of which the

most important is standardization. These non-returnable containers provide the best means of presentation of high quality apples and pears in quantity.

The need for economy after the war together with high cost resulted in a temporary virtual elimination of non-returnable containers.

MARKETING FACILITIES.

Marketing of produce may take place immediate upon harvesting, or it may be required for storage in so far as the sample and variety are suitable for this purpose. Whichever is the case, facilities are needed for the preparation of the fruit for market. Adequate accommodation is required for the reception of fruit from the orchard, normally accommodation for one week's supply will suffice in this respect, also there must be accommodation for a limited quantity (i.e. 2 or 3 days' output) prepared for despatch. In addition to this there must be operational room to attend to the business of the sorting, size-grading, packing, box sealing, and conveyance to the despatch bay.

The requirements for accommodation thus outlined are concerned only with the post-picking operations. Room is also needed for orchard-boxes and standard apple boxes whilst at rest; provision too is needed for the storage of box-lining materials, wrapping papers and the assembly of standard apple boxes. In fact, for any large-scale fruit farming operation, a well balanced factory layout is needed to ensure efficient and expeditious handling of the crops. Obviously storage calls for additional facilities to those already enumerated.

STORAGE.

Plums, cherries and the quickly perishable soft fruits do not lend themselves to long period storage, and as a rule, should be marketed as soon after harvesting as possible. This applies most especially to fruits such as strawberries, raspberries, blackberries, red and blackcurrants and ripe gooseberries, whereas the less soft kinds may be held in cool storage for short periods. At times this may help to ease a marketing difficulty and at others to secure a definite market advantage.

For apples and pears, the future well-being of the industry devoted to their production is likely to be increasingly linked up with the provision of storage facilities. In the event of a grower being committed to market his crops almost as soon as they are harvested, this consideration becomes the primary

limiting factor of the acreage that can be profitably grown. Furthermore, the margin between glut conditions and comparative scarcity is a very narrow one; and this means that market conditions at the time of harvesting seldom afford opportunity for produce to realize its true value. Storage provides the means to spread the marketing over a longer period and thus makes possible a corresponding expansion of the acreage that can be grown profitably.

Storage may sometimes be resorted to as a result of the administrative difficulty of despatching consignments, within the short period required. In such cases only short period storage, of say one or two weeks, is envisaged and all that is required is cold room facilities for the express purpose of reducing the temperature of the fruit so as to lengthen the period of marketability.

APPENDIX IV

THE CORRECTION OF MINERAL DEFICIENCIES BY TABLET INJECTION

Reference has already been made concerning the correction of Iron and Manganese deficiencies by the insertion of tablets supplying the nutrient required, into woody stems or branches (see p. 127). Whereas Manganese deficiency can be corrected by spraying with a solution of Manganese Sulphate as well as by the insertion of Manganese Sulphate tablets, Iron deficiency at present can only be satisfactorily corrected by the insertion of a solid salt supplying this element. Tablets of Ferrous Sulphate are usually employed. The normal size of the tablets is $\frac{7}{16}$ inch in diameter, and each tablet supplies one gramme of the nutrient salt. These are intended for trees which have a greater stem diameter than 2 inches, and they are inserted into holes made in the main stem or branches, only simple equipment being necessary for the purpose.

EQUIPMENT.

Brace and Bit.

The holes are made in tree trunks or branches with the aid of a ratchet brace fitted with an Irwin or Irwin-pattern bit of $\frac{1}{2}$ inch diameter.

Pill Pusher.

This consists of a steel tube, the internal diameter of which is $\frac{1}{2}$ inch; it has a tapering bevel at one end to form a snout which helps the operator to place the tube in direct line with the holes bored into tree stems. The tube should be about $3\frac{1}{2}$ inches long, and it is convenient to have a wooden cylinder covering the central portion to serve as a handle; thus the two ends of the tube project either side of the handle.

A cylinder of solid steel $\frac{11}{32}$ inch in diameter forms the plunger of the pill pusher. This should be fitted with a handle at one end, but the actual naked part of the plunger, protruding beyond the handle, should be 4 inches long. This means that when the plunger is passed through the $3\frac{1}{2}$ inch tube, it will protrude by $\frac{1}{2}$ inch.

Plugs.

Each hole should be sealed after the tablets have been inserted. Small discs of ½ inch diameter are used for this purpose. Suitable discs may be punched out with a ½ inch leather punch from such materials as sheets of cork or old lino.

Ruler.

A ruler is required for measuring the stem diameter of trees to be treated.

INSERTION PROCEDURE.

The Holes.

First of all the stem diameter is measured, because the number of holes required equals the stem diameter in inches. Thus there should be one hole for approximately every 3 inches of the stem circumference.

In order to avoid any structural weakness that might result by making all the holes on the same horizontal plane, they should be staggered. The actual depth of the holes, although governed by dosage, should be deep enough to allow both tablets and plug to reside in the woody parts of the stem, i.e. beneath the bark.

Dosage.

As would be expected, dosage differs according to the size of the tree being treated. Calculation is based on the area of a horizontal cross-section of the stem being treated. A regular increase in dosage is made for every additional 3 square inches.

TABLE SHOWING NUMBER OF ONE-GRAMME TABLETS FOR STEMS OF DIFFERENT DIAMETERS TO CORRECT IRON AND MANGANESE DEFICIENCIES.

Stem diameter in inches (and number of holes per stem).	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Number of one-gramme tablets of Ferrous Sulphate or Manganese Sulphate per Tree.	3	4	7	10	14	16	18	25	30	36	42	50	56	66
Number of one-gramme tablets per hole.	1	1	1–2	1–2	2	2	2	2–3	2–3	3	3	3–4	3–4	4

The dose is divided as equally as possible between the total number of holes.

Using the Pill Pusher.

First, a plug is put in at the snout end, followed by the number of tablets required for a single hole. The snout is then placed flush over the hole, after which the plunger is pressed home; this completes the operation. The tablets should come to rest in heart wood and the plug should be below the bark, leaving no impediment for a normal callous to form over the wound so as to minimize the risk of bark injury.

Pill Pusher for Tablet Injection.

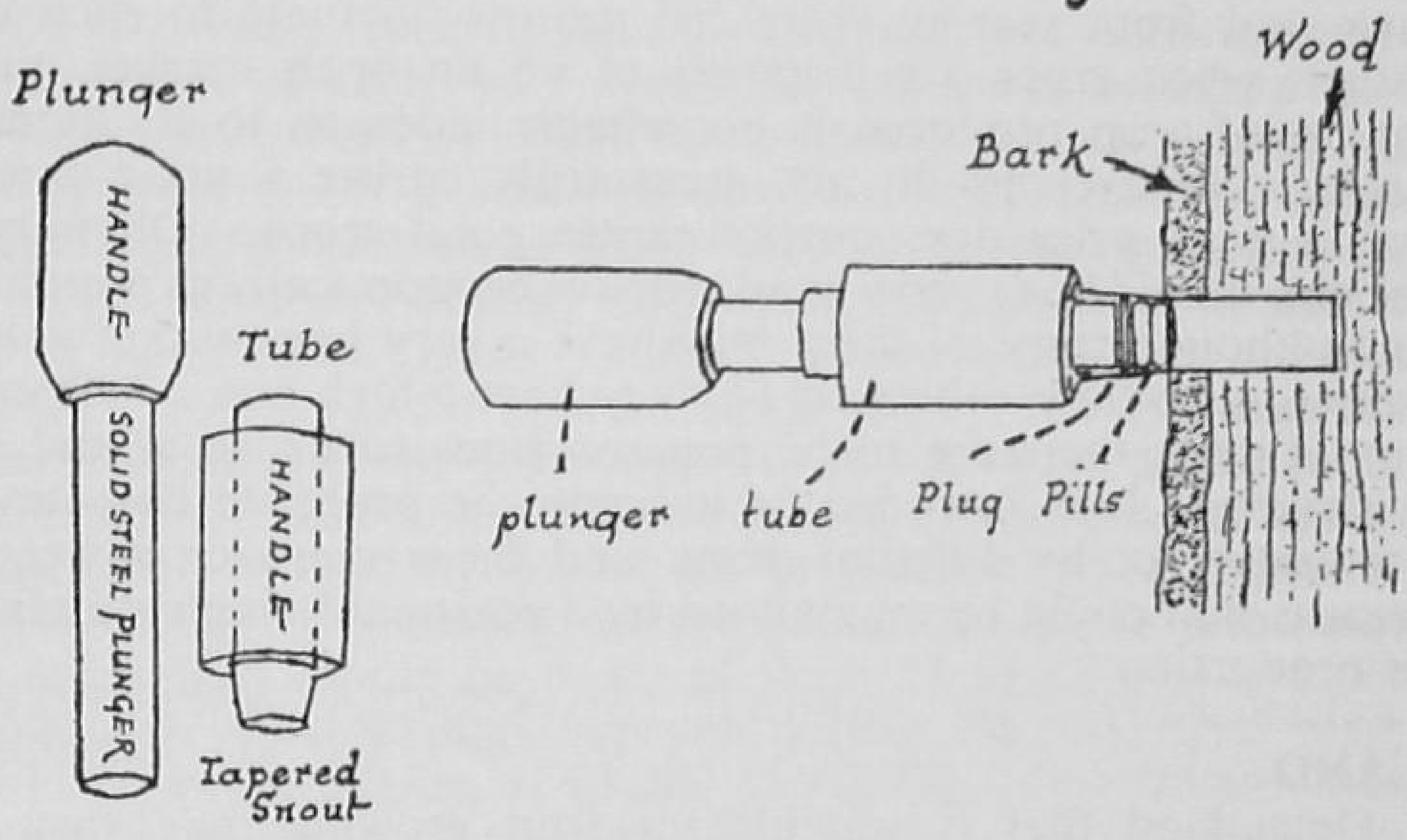

Fig. 29

March is the best time to inject trees by the tablet injection method. Whilst it is possible to do so at other times, there is some risk of foliage injury if injection is carried out during later Spring and Summer.

APPENDIX V

COSTINGS

One question that is paramount in the minds of prospective fruit growers is, what is it going to cost and what is the prospect of return? Given the required ability and knowledge, it is justifiable to ask whether fruit-growing is a sound business. To these questions it is impossible to give the straightforward answer, since costs of production differ so much from farm to farm and from year to year, and returns fluctuate to such an extent, when crops are disposed of on an open market, that weight of crop produced is no reliable index as to its money value. Good crops do not necessarilly ensure a good price, and a good price does not guarantee good crops. Obviously the aim should be to grow good crops as economically as possible, and although some of these may have a very low market value from time to time, others are likely to have a high one. Without any attempt therefore to be precise—since to do so would be misleading—it is intended to indicate the probable cost-range accounted for by different items, and the average crop weight returns that could be maintained by a reasonably high standard of production.

LAND.

Open land that is suitable for fruit growing may vary in price from £30 to £150 per acre. Calculated on a 100 acre basis, this represents a range of from £3,000 to £15,000. The price is not necessarily an index of suitability for the purpose; and this can only be ascertained by examination. The price of land may have more to do with locality, soil fertility as judged from the nutritional aspect and the standard of farming that has been maintained. Assuming that there is no depreciation on land value and that an annual charge of 3 per cent. on capital is allowed, a figure of £1 to £3 per acre per annum is arrived at; this is a normal range of rental.

EQUIPMENT.

The minimum provisional equipment required is a tractor of the Four Wheel or Crawler types, a set of discs or a cultivator

and a plough unit; these will cost from £500 to £1,500. Allowing for full depreciation in five years, this involves a charge of £1 to £3 per acre on the 100 acre unit. Right at the outset, some provision for spraying is needed, and although for the first two years, two hand operated sprayers of the knapsack type will suffice, costing about £10, after this stage it is necessary to embark on a power outfit. Initially, this may be of the power take off mobile type (see p. 204) costing about £300 to £500, and later of the underground mains type, involving an outlay of from £1,500 to £2,000, or alternatively the mobile system may be employed. During the course of about 15 years something in the region of £1,000 to £2,500 will be spent on spraying equipment. This averages out at approximately 15s. to £2 per acre per annum.

For overheads, such as maintenance and fuel running costs, an allowance of £1 to £2 per acre per annum should be made. On top of this, there is such equipment as spades, hoes, brushing hooks, pruning saws, secateurs and sundry tools, on average something in the region of £10 will be spent per annum, or 2s. per acre. Growers of soft fruit, such as raspberries or strawberries, invariably require a hand or power operated dusting machine, and the latter is often employed by tree-fruit growers once productive crops are being grown. A trolly and manure distributor are needed at the outset. Furthermore, some means of transport to and from railhead or market in the nature of car, van or lorry is almost indispensable. In all, an allowance for equipment should be made of from £3 to £8 per acre per annum. A total capital expense during the first five years would be in the region of £1,300 to £3,000. One tractor may not suffice where much soft fruit is grown or considerable inter-cropping is done.

MATERIALS.

The principal items in this respect are planting materials or stock (i.e. trees, bushes, plants), manures, spray materials and fencing and materials for tree-support, fuel, replacement and repairs.

Planting Materials or Stock.

(i) Strawberries are planted at approximately 14,000 plants per acre and these cost £2 to £4 per 1,000 representing £28 to £56 per acre. A planting of strawberries lasts on average 4 to 5 years giving three to four crops, this means that the cost of plants works out at from £7 to £14 per acre per annum. Once

an initial planting is established, it should be possible for a grower to raise material at a cheaper rate for subsequent plantings.

(ii) **Raspberries** are planted at approximately 7,000 canes per acre and cost in the region of from £5 to £12 per 1,000. For a total cost of £35 to £84 per acre, and life of from 8 to 10 years, the average annual cost would be from £4 10s. to £10 10s. per acre.

(iii) **Blackberries and Loganberries** are planted at approximately 800 per acre and cost in the region of £20 to £40 per 1,000. Given a total cost of £16 to £32 per acre, and a life of from 12 to 15 years, the average annual cost would be from £1 to £2 15s. per acre.

(iv) **Blackcurrants, Gooseberries and Redcurrants** are planted at approximately 1,500 per acre and cost in the region of £15 to £30 per 1,000. Given a total cost of £22 10s. to £45 per acre, and a life of from 10 to 12 years, the average annual cost would be from £2 to £4 10s. per acre.

(v) **Apples and Pears.** The number of these fruits planted per acre varies greatly, especially for apples. On a normal bush or standard plant it will range from 80 to 200 per acre. For a Cordon or Dwarf Pyramid plant it will be as many as 1,000 to 2,000 trees per acre. The cost of trees may vary from £20 to £40 per 100. The establishment of 1 acre for normal planting distances will be £16 to £80 per acre, and for a Cordon or Dwarf Pyramid plant £200 to £800 per acre. The anticipated life is from 25 to 50 years, giving an annual average cost of 6s. 6d. to £3 4s. for a normal plant and £4 to £35 for Cordons and Dwarf Pyramids.

(vi) **Plums** are planted at approximately 100 per acre and cost in the region of £25 to £50 per 100. Given a total cost of £25 to £50 per acre, and a life of 15 to 25 years, the average annual cost would be from £1 to £3 7s. per acre; 20 per cent. should be added as an allowance for gapping up when casualties occur during the first five years.

(vii) **Cherries.** This crop is planted at from 20 to 50 per acre and the cost is 10s. to £1 per tree, giving a total of £10 to £50 per acre. The life of a cherry orchard averages from 40 to 60 years, giving an annual charge on planting of 3s. 6d. to £1 5s. per acre. Since this crop is usually interplanted with plums, corresponding additions should be made. Also in the case of cherries, 50 per cent. should be added as an allowance for gapping up where there are casualties during the first 10 years.

Fertilizers and Manures.

The amount it is necessary to spend on fertilizers and manures varies greatly. At the outset soil fertility, so far as the nutritional and physical aspects are concerned, is the primary factor in determining necessary expenditure. The kind of crop to which the land is devoted also governs nutritional requirements. On soil that is in a high state of fertility little, if any, need be spent so far as tree fruits are concerned for the first 4 to 5 years. For soft fruits, which need generous husbandry, and for soils liable to drought effects requiring frequent applications of bulky manures, the bill is rather a heavy one. Furthermore, the expenditure may be heavier during certain years than during others.

The cost range per acre is likely to range from £3 to £35. In the former case, allowance is made for 2 cwt. Sulphate of Potash per acre and 3 cwt. " Nitro-Chalk "; in the latter case, for an application of Dung at 10 tons per acre or Shoddy at 2 tons, 4 cwt. Sulphate of Potash, 4 cwt. Epsom Salts, and 4 cwt. Superphosphate. The average annual cost per acre ranges from £3 to £15.

Spray Materials.

Apples and pears require most spraying, but even for these there is a great difference between young trees and those that are mature. For the first five years the cost will range between £2 to £5 per acre. After this period, it will be more in the region of £8 to £20. Strawberries, Raspberries, Loganberries and Blackberries, which require two or three dustings, and possibly one spraying, costing between £5 to £10 per acre. Plums and cherries, which require two or three sprayings per annum, cost on an average £10 to £15 per acre for established trees, and correspondingly less for younger ones. Blackcurrants, Gooseberries and Redcurrants, which also require two or three sprayings, consume less wash than big trees and cost £5 to £12 per acre per annum.

Fencing and Tree Supports.

(See pp. 65, 74). Fencing is an expensive item, but essential when protection against rabbits and hares is necessary. Fruits such as cherries, blackberries, loganberries and gooseberries may be excepted, also strawberries, raspberries, blackcurrants and redcurrants are not subject to the most extensive damage, and some discretion in the matter of fencing these may be exercised. The cost of fencing for protecting against small mammals necessitates 4 feet wire netting, straining wires,

sometimes barbed wire, supports and straining posts. On average, 1,000 yards of fencing has to be carried out for 10 acres and the approximate cost is £100 to £150, or £10 to £15 per acre. For smaller units than 10 acres, the cost per acre is higher, since on average something like 300 yards of fencing is required to enclose a single acre. It is fair to assume that the cost range is from £10 to £25 per acre, for which one could anticipate a life of 10 years, so that in such a case, the annual cost is from £1 to £2 10s. per acre.

For most tree fruits, it is highly desirable to provide supports in the form of stakes, especially for young trees, to prevent them from being blown over. Usually, staking is of temporary duration, say for 6 to 8 years, although for pears on Quince such as Fertility and Williams', and apples on Type IX rootstock, permanent support is needed (see p. 84). The cost will vary greatly, depending on the form of staking employed, the number of trees to be staked per acre, and whether tall or short stakes are needed. According to the method employed and the size of stakes, the cost of materials for staking an individual tree will range from 6d. to 1s. 3d. For Standard trees at wide planting distances, the approximate cost per acre is £4, and for close planted bush trees about £10 per acre. One staking will last for a period of three years, thereby necessitating an annual expenditure for the first 6 to 8 years of from £1 6s. to £3 6s. per acre per annum.

As compared with such crops as Bush apples, additional provision for support is needed by Cordons, Dwarf Pyramids, loganberries, blackberries and raspberries. Each of these fruits just enumerated needs something in the region of 1,500 to 2,200 yards of fencing support per acre. Less elaborate provision is required for raspberries and Dwarf Pyramids than for the other fruits referred to, although it will run to something like £20 to £40 per acre, which can be reckoned at £1 to £2 per acre per annum. Supports for Cordons, loganberries and blackberries cost something in the region of £50 to £70 per acre or £2 10s. to £3 10s. per acre per annum. Cordons need additional support in the early years in the form of bamboo canes to which the trees can be tied after fixing them to the wires. These canes cost £8 to £16 per 1,000, giving a figure of £8 to £32 per acre. Support of this description can be dispensed with after about 4 years.

Fuel, Repairs and Replacements.

Figures including these items are not easy to compute since seasonal, soil and crop variations among other factors, combine

to account for considerable differences. It is fair to assume that 8 to 12 gallons of fuel would be required per acre per annum, or say 10s. to £1. For Repairs and Replacements an allowance of £1 to £2 per acre should be made.

LABOUR.

The labour force required for efficient working varies considerably according to the nature of crops grown. For a 100 acre fruit farm devoted to a range of fruit crops, one man per 10 to 15 acres is normally required. An allowance therefore should be made of approximately £17 to £25 per acre per annum. Where soft fruits are grown, additional labour will invariably be required at the harvesting season and the cost of harvesting alone may well be £15 to £50 per acre.

Assuming that the above figures present a fair assessment of the probable cost range, the average cost to establish one acre of bush apples for the first six years, excluding the cost of the land would be approximately £270, it could be as low as £150, or as high as £425.

Approximate Average Cost to Establish an Acre of Bush Apples or Pears for the First Six Years.

	£
Equipment	30
Trees	30
Manures	50
Sprays	20
Fencing	12
Stakes	15
Fuel, Repairs, Replacements	14
Labour	100
	£271

HARVESTING AND MARKETING.

It should be borne in mind that considerable cost is entailed in the harvesting and marketing of fruit, in fact they are the costliest items. Obviously they differ greatly according to the facilities available and methods adopted from farm to farm. In the case of apples and pears it ranges from £5 to £10 per ton; for cherries, £15 to £20 per ton; for plums, £8 to £16. Harvesting and marketing of soft fruits accounts for an expenditure of £25 to £30 per ton for strawberries and blackcurrants, rather less for gooseberries, blackberries and logan-

berries and rather more for raspberries. The storage of apples and pears would account for an additional expenditure of £10 to £15 per ton.

PROBABLE CROP YIELDS.

As would be expected, soft fruits come into bearing sooner than tree fruits. Strawberries occupy the land about 18 months before they are in full production. After two crops are harvested they normally decline. Raspberries, blackcurrants, loganberries and blackberries normally require 2½ years before substantial crops can be expected. Gooseberries and redcurrants require 3½ to 4½ years. Although Cordon and Dwarf Pyramid apples normally commence to give something of a crop 18 months after planting, production of any consequence cannot be depended upon until they have been established 3½ to 4½ years. Bush apples and pears and Half-standard plums may yield a return after 4 years, but it is more generally after 6 years. Standard apples require approximately 8 to 12 years, and cherries 10 to 15 years.

TABLE SHOWING PROBABLE CROP YIELDS IN TONS PER ACRE FROM WELL GROWN AND WELL SITED FRUIT.

Crop	*Years after Planting.*					
	1 *Yr.*	2 *Yrs.*	3 *Yrs.*	4 *Yrs.*	5 *Yrs.*	6 *Yrs.*
Strawberries	—	1–3	1–3	½–1	—	—
Raspberries	—	0–½	1–2	2–4	2–4	2–4
Blackberries	—	—	½–2	2–3	2–3	2–3
Loganberries	—	—	½–1	1–2	1–2	1–2
Gooseberries	—	—	—	0–¼	¼–½	½–2
Blackcurrants	—	0–½	½–1	1–3	1–4	1–4
Redcurrants	—	—	—	0–½	1–2	2–4
Apples (Bramley) ..	—	—	—	—	—	—
,, As Bush (Worcester)	—	—	—	—	0–1	1–2
,, As Bush (Cox) ..	—	—	—	0–1	0–1	0–2
,, (Cox) Cordons and Dwarf Pyramids..	—	0–½	0–1	0–2	1–4	1–6
Pears as Bush	—	—	—	—	0–1	1–2
Plums	—	—	—	—	0–2	1–4
Cherries	—	—	—	—	—	—

TABLE SHOWING PROBABLE CROP YIELDS IN TONS PER ACRE FROM WELL GROWN AND WELL SITED FRUIT—*cont.*

Crop.	*Years after Planting.*						
	7 *Yrs.*	8–10 *Yrs.*	10–12 *Yrs.*	12–14 *Yrs.*	14–16 *Yrs.*	16–20 *Yrs.*	20–30 *Yrs.*
Strawberries ..	—	—	—	—	—	—	—
Raspberries ..	1–3	1–2	1–2	—	—	—	—
Blackberries ..	2–3	2–3	1–2	1–2	—	—	—
Loganberries ..	1–2	½–2	½–1	—	—	—	—
Gooseberries ..	1–4	1–4	1–4	½–2	—	—	—
Blackcurrants ..	1–4	1–2	½–1	—	—	—	—
Redcurrants ..	2–4	2–4	2–4	1–2	—	—	—
Apples (Bramley)	—	0–4	2–6	2–8	4–10	6–12	8–20
„ As Bush (Worcester)	1–4	2–6	4–8	4–12	8–16	8–16	8–16
„ As Bush (Cox) ..	1–4	1–6	2–6	2–8	2–8	2–8	2–8
„ Cordons and Dwarf Pyramids	2–6	2–8	2–8	2–8	2–8	2–8	2–8
Pears as Bush ..	2–4	2–6	4–8	4–10	4–10	4–10	4–10
Plums	2–6	2–8	4–10	4–15	4–15	4–10	4–10
Cherries	—	0–¼	¼–1	1–2	2–4	2–4	2–6

APPENDIX VI

A NOTE ON SPRAY MATERIALS

It is essential that fruit growers should familiarize themselves with the principal materials employed for spray purposes.

The range of spray materials employed by the fruit grower is varied but not large. The materials used are determined by the nature of the pests or diseases to be prevented or controlled, the time of the year the application is made, and the kind and variety of fruit.

With all materials, suitable concentrations in sufficient quantity should be applied within the appropriate period and in suitable weather, in order to provide effective control. Stronger concentrations than those prescribed for the control of specific pests and diseases are in many instances liable to have injurious effects on buds, foliage or fruits and such should be avoided in the interests of both efficiency and economy.

1. TAR DISTILLATE.

There are two types, viz. (i) miscible (i.e. where the emulsion is formed by the addition of water) and (ii) stock emulsion (i.e. where the emulsion is formed by processing the concentrate).

Both the miscible and the stock emulsion types have a distinctive usefulness. Whereas miscible tar-oil sprays are usually preferred because of ease in handling and ease with which the diluted spray can be seen when applied, the stock emulsion type can be used with hard and saline water; the miscible form being unsuitable for some waters because they cause a precipitation of the emulsifier.

Care should be taken to protect tar-oil washes from exposure to severe frosts because in the stock emulsion type, the emulsion is liable to break, and in the miscible type, the oil is liable to separate into layers of different compositions. Tar-oil sprays are employed principally for their ovicidal properties; they are applied during the Winter before " bud burst."

2. PETROLEUM OIL.

As with tar distillate, there is the choice of the miscible and stock emulsion types. Whether a petroleum spray is suitable

for Winter and Summer spraying depends chiefly upon the degree of refinement.

3. D.N.O.C.

This wash effectively combines dinitro-ortho-cresol and petroleum in a single spray; under certain circumstances, it serves to obviate the need to make separate applications of a tar-distillate and petroleum oil. D.N.O.C. should be used during Winter when bud movement is taking place, but not later than " bud burst."

4. NICOTINE.

Since nicotine is soluble in water and hydroscopic, it is important that the standard of purity be ascertained. A commercially pure product is employed by the majority of growers containing 95 to 98 per cent. nicotine. Free nicotine or nicotine sulphate are incorporated with various dust carriers and are used for dry spraying. The insecticidal efficiency of nicotine is enhanced when the temperature is over 60° F. and when atmospheric conditions are relatively still. Nicotine is used principally in Spring sprays as an ovicide and as a contact poison.

5. LEAD ARSENATE.

This poison is purchased principally in two forms, viz. (i) as powder and (ii) as paste. It is employed in both Spring and Summer sprays.

6. DERRIS AND LONCHOCARPUS.

The roots of Tuba-root and Lonchocarpus are employed in the preparation of sprays and dusts. Their chief toxic properties are attributed to their rotenone content, and whilst harmless to animals, they are valuable contact poisons against several fruit pests.

7. D.D.T.

There are three principal formulations of D.D.T. employed at present by fruit growers for pest control purposes, viz. (i) oil emulsions, (ii) suspensions and (iii) powders. See p. 229.

8. LIME SULPHUR.

This is a product of milk of lime and sulphur which have been subjected to a boiling process. Injury to foliage may result from applications of lime sulphur to some fruit varieties,

even with low concentrations. Care should therefore be taken to ascertain whether the varieties grown are sulphur tolerant or sensitive. In some cases of sulphur intolerance, all forms of sulphur as sprays should be avoided when foliage is present, but in others, sulphur sprays of lower fungicidal efficiency with a less damaging phytocidal action may be employed, e.g. "colloidal" sulphur or "dispersible" sulphur.

9. BORDEAUX MIXTURE.

The normal 1 per cent. Bordeaux mixture consists of 10 lb. copper sulphate, 10 lb. quicklime (or 15 lb. hydrated lime) and 1,000 lb. (i.e. 100 gal.) of water. Bordeaux mixtures are employed as fungicides and bactericides. They are employed at different strengths depending upon varying circumstances and the formulae are expressed by stating first the weight of copper sulphate in lb., followed by the weight of quicklime, or hydrated lime in lb., followed by the volume of water. Thus a 1 per cent. Bordeaux is expressed 10 : 10 : 100, when quicklime is used, and 10 : 15 : 100 when hydrated lime is used. In the present book, references to concentrations incorporate both expressions, e.g. 10 : 10 (15) : 100.

Separate concentrate solutions of copper sulphate and hydrated lime at the rate of 1 lb. and 1½ lb. per gallon of water respectively from the "stock" from which Bordeaux mixture can be made on the farm. In this case, a 1 per cent. Bordeaux would be obtained from 10 gal. copper sulphate stock, 10 gal. hydrated lime stock and 80 gal. water. Some growers favour the use of proprietary Bordeaux pastes in preference to making a Bordeaux mixture themselves.

Bordeaux mixture cannot be employed with safety on all varieties of the different kinds of fruit at all times of the year. With some varieties, very severe injuries to fruits would result following post-blossom applications. Sometimes it is used to replace lime sulphur on sulphur sensitive varieties. Susceptibility to copper injury should be determined before employing copper sprays.

In addition to Bordeaux sprays, copper lime dusts are employed as a fungicide auxiliary to spraying.

10. VENTURICIDE AND MERCURATED LEAD ARSENATE.

Of recent years an organo-mercurial, phenyl mercury chloride has been successfully employed at 0·005 per cent. for the control of Apple Scab (see p. 222). This material is now sold under

the trade name of Venturicide. Similarly, phenyl mercury chloride has been incorporated with arsenate of lead, thus yielding a combined fungicide and insecticide which is sold as Mercurated Lead Arsenate.

11. WETTERS OR SPREADERS.

These include a variety of auxiliary spray materials employed to improve coverage.

12. PRE-HARVEST DROP SPRAYS.

Difficulties at harvest time often occur with apples and pears, due either to the quantity of fruit to be gathered and consequent loss due to fallen fruits or to the natural tendency of a variety to drop its fruits when approaching maturity. When difficulties of this nature occur with such varieties as Beauty of Bath (although this variety does not appear in the list of recommended sorts, the introduction of Pre-harvest Drop Sprays has altered the position with regard to its commercial usefulness), Miller's Seedling and Worcester Pearmain apples and Conference pears, spraying may be done to retard the dropping of fruits.

The material most widely employed for the reduction of pre-harvest drop is x-naphthalene-acetic acid at dilutions of from 5 to 10 parts per million. Several commercial preparations are available in forms convenient for dilution with water. Spraying should be done thoroughly, since it is required to cover the stalks of the fruits in order to be effectual in retarding the formation of the abcission layer between the fruit stalks and spurs. Application should be made at a period approximately 10 days before the expected picking date. Spraying does not retard the actual maturing of the fruits and therefore only serves to lengthen by a few days the harvesting period. There are also indications that these sprays can also be employed for some varieties to reduce the heavy drop of fruits that normally occurs a few weeks after blossoming.

13. MANGANESE SULPHATE.

In cases of a manganese deficiency, manganese sulphate may be employed as a spray to correct the deficiency.

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